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GARTSIDE DAM

MANUAL FOR OPERATION AND MAINTENANCE

Montana Department of Fish, Wildlife, And Parks
Field Services Division
Design and Construction Bureau
1420 East Sixth Avenue
Helena, MT 59620

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PROJECT DESCRIPTIPON

OVERVIEW

Gartside Dam is located on Crane Creek in Richland County. The project is approximately ten miles southwest of Sidney, Montana and about one mile northwest (upstream) of the town of Crane, Montana (see Figures 1 and 2). Figure 3 provides a general layout of the dam, spillway and outlet works.

The dam is owned by the Montana Department of Fish, Wildlife, and Parks (DFWP) and is managed by the Parks Division of the DFWP. The DFWP Makoshika State Park Office manages and operates the dam. The DFWP is responsible for repairs and maintenance of the dam. The DNRC State Water Projects Bureau (SWPB) inspects the dam annually and provides engineering assistance as needed.

Water in the reservoir is primarily used for recreation and fisheries water supply.

EMBANKMENT

The curved-axis earth-filled dam is 31 feet high and 1,350 feet long with a crest width of 28 feet. The dam has a 10 foot wide berm across the downstream toe to increase the strength and stability of the embankment.

The dam is believed to originally have been a beaver dam that was covered with soil by a local rancher in about 1900 to provide a more adequate water supply for cattle. The dam was enlarged in the 1930's to a height of 6 or 7 feet. The dam was raised further in 1955 and again in 1962 to it current height of 31 feet.

In 1982 a large depression formed around the drop inlet structure causing damage to both the embankment and the drop inlet structure. The dam was breached by DNRC in 1985 to alleviate dam safety concerns. A channel was excavated through the embankment and the outlet works was moved.

In 1990, the dam embankment was reconstructed. The repair included adding a 10 feet wide berm across the downstream toe of the of the dam, decreasing the upstream slope of the embankment, and adding cobble slope protection.

OUTLET WORKS

The outlet works, located in the left abutment of the dam, was replaced as part of the 1990 rehabilitation. Prior to 1990, the outlet works consisted of a corrugated metal pipe that was in very poor condition. Since the rehabilitation, there have been few problems. The only significant problem occurred in 1995 when the gate stem separated from the outlet gate. This resulted in the reservoir being drained. Once the gate and stem were repaired, stop nuts were placed on the control stem to prevent the gate from being closed too tight or opened too much.

The outlet works consist of an intake structure, an inclined slide gate, a 30-inch diameter reinforced concrete pipe (RCP) conduit, and an outlet structure. The intake structure is a rectangular concrete structure with a trash rack on top. There is a 30-inch diameter steel transition section between the intake structure and the RCP conduit. The RCP conduit is 201 feet long with a flared concrete wall outlet stilling basin at the end.

The 16-inch square inclined slide gate covers the steel intake pipe opening. The control for the gate is located on the upstream shoulder of the dam in a concrete vault. The gate is connected to the gate control structure by a 1-1/2-inch diameter stainless steel stem which is encased in a galvanized steel pipe filled with hydraulic oil. The gate control structure consists of a gate lift pedestal with a horizontal wheel attached to the upper end of the stem. Operation of the sluice gate is conducted manually by turning the wheel to open or close the gate.

A 3-inch diameter galvanized vent pipe extends from near the gate control structure into the inlet structure to provide air to the gate. The vent pipe and gate stem are placed in a shallow trench in the dam embankment.

SPILLWAY

The spillway is located in the right abutment of the dam. During the 1990 rehabilitation, the spillway was enlarged and lined with soil-cement.

The spillway consists of a curved sand-gravel-grass lined approach channel, an uncontrolled soil-cement broad crested weir structure approximately 144-feet wide, and a soil-cement chute approximately 180 feet long which narrows to 100 feet. At the end of the soil-cement chute there is a concrete cutoff wall. A concrete revetment mattress is anchored in lean concrete to protect the end of the spillway chute from erosion.

DRAINS

During the 1990 rehabilitation, a blanket drain was constructed along the downstream toe of the dam. The drain is located under the toe berm and consists of two feet of gravel wrapped in filter fabric. The filter fabric is covered with larger coarse gravel and is approximately 10 feet wide. The drawings for the dam show that the gravel is surrounded by a geotextile on the top, upstream side and the bottom, with the downstream side being open.

Also in 1990, a drainage system was constructed under the spillway. It consists of a 3-inch diameter PVC perforated collection pipe located just downstream from the crest that connects into a 4-inch diameter perforated PVC pipe. The 4-inch pipe runs down the center of the spillway and exits through the cut-off wall at the downstream end of the spillway into the spillway exit channel. The pipes are located in a gravel filled trench.

In addition, there are several 2-inch diameter weep holes which were drilled into the edge of the spillway floor at a 40-foot spacing interval. These drains were designed to relieve uplift pressures on the soil-cement lining.

In 1998, a drain was installed along the left side of the outlet structure to help control seepage water that was flowing over the outlet sidewalls.

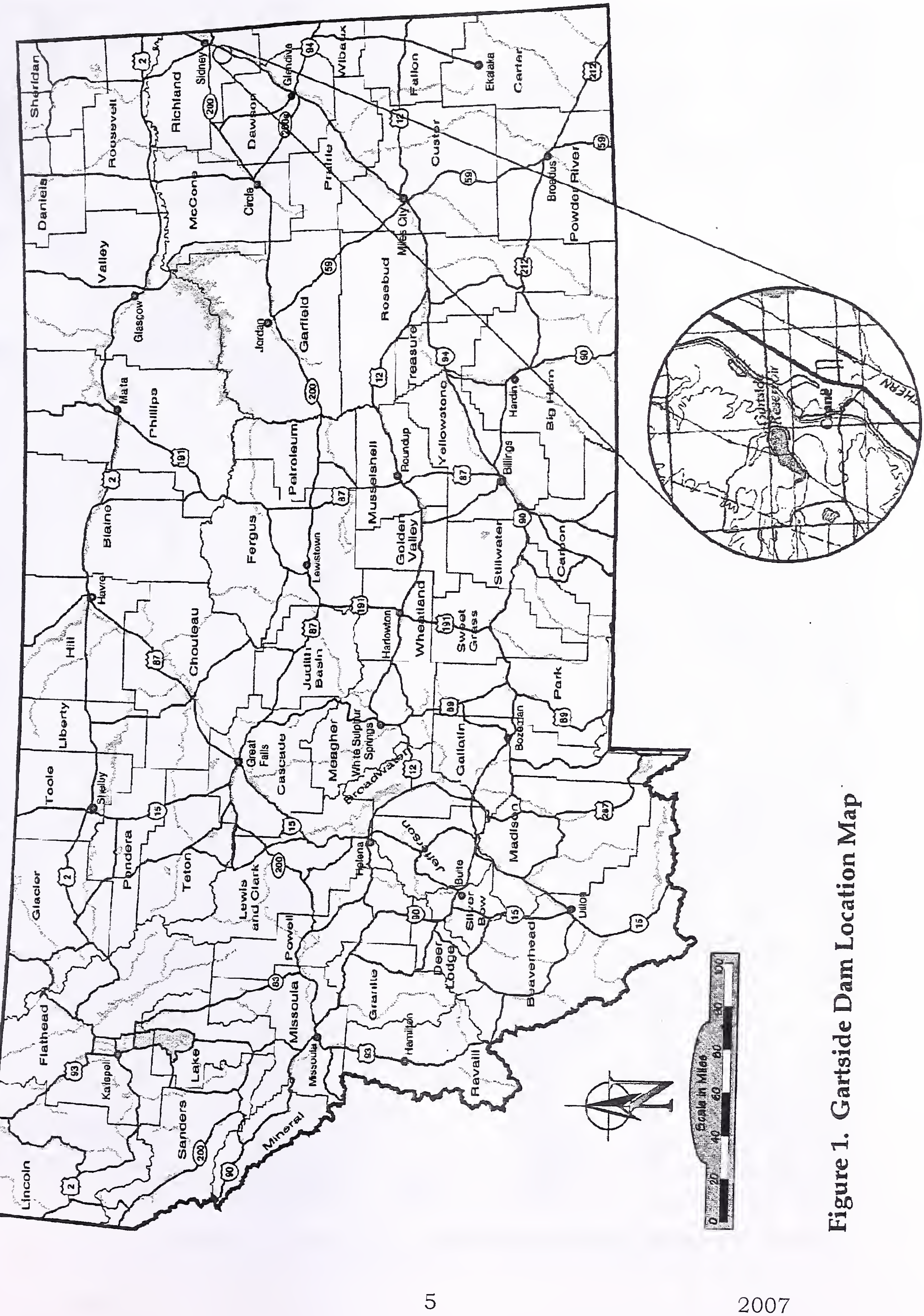

Figure 1. Gartside Dam Location Map

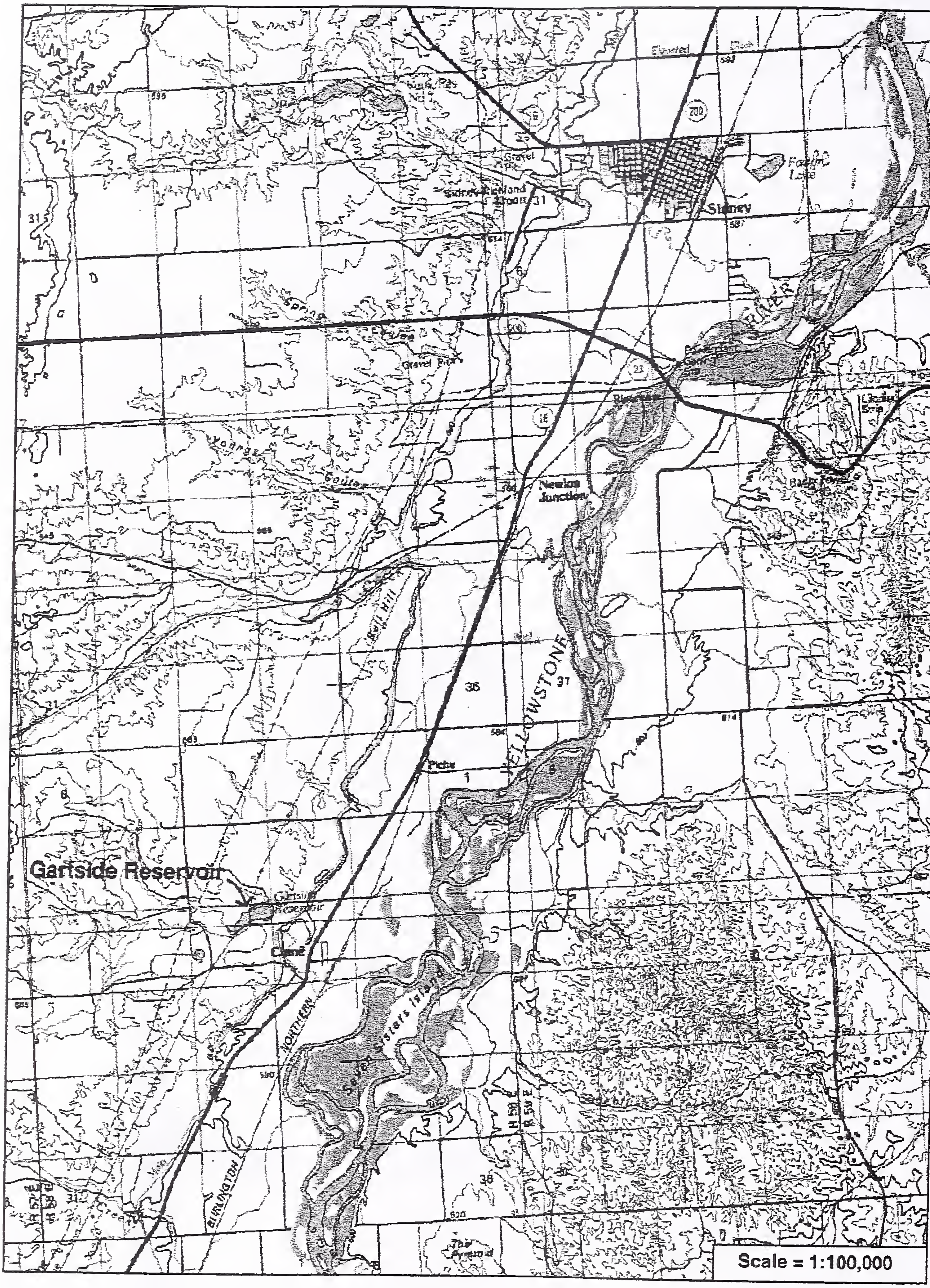

Figure 2. Gartside Dam Vicinity Map

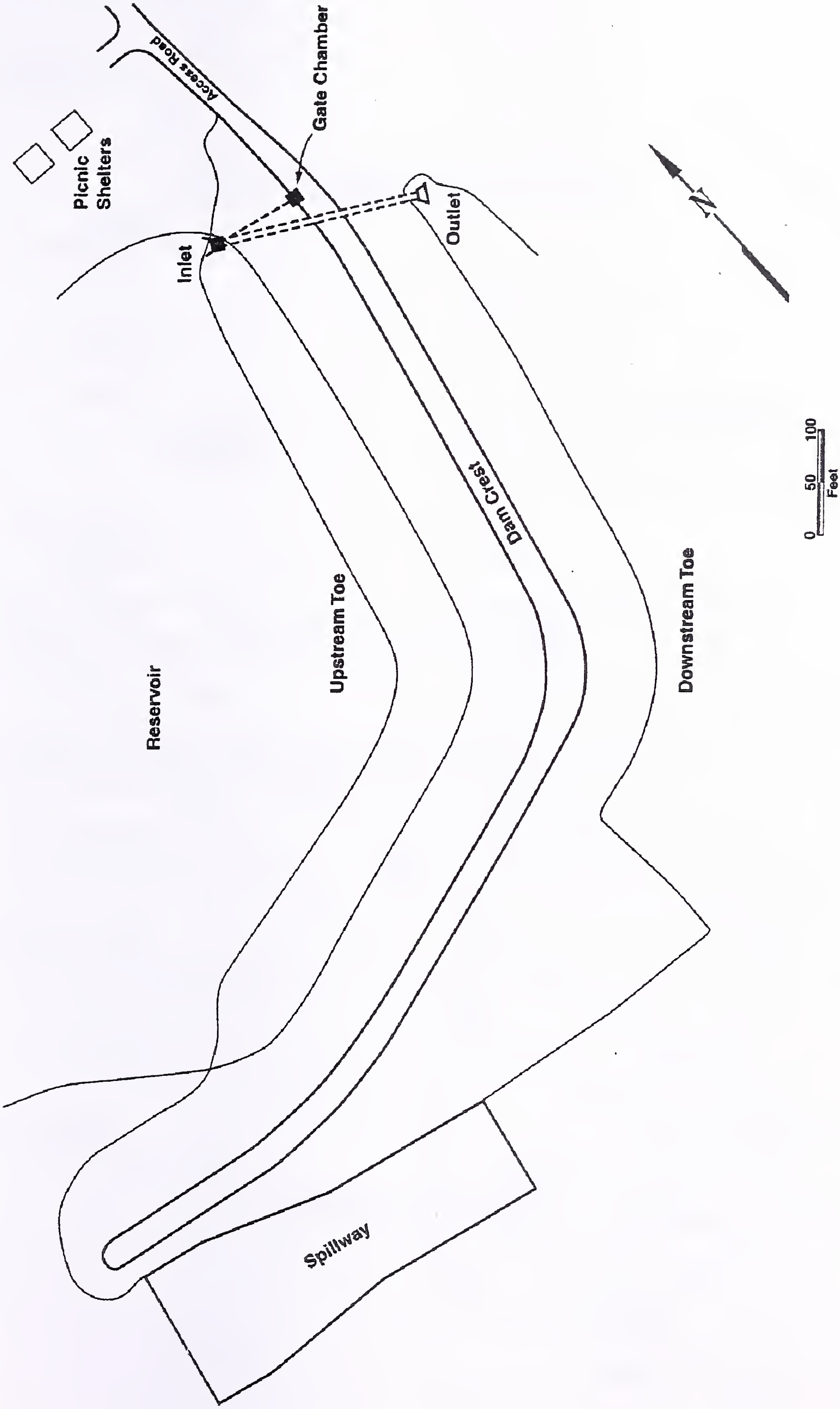

FIGURE 3. GARTSIDE DAM GENERAL LAYOUT

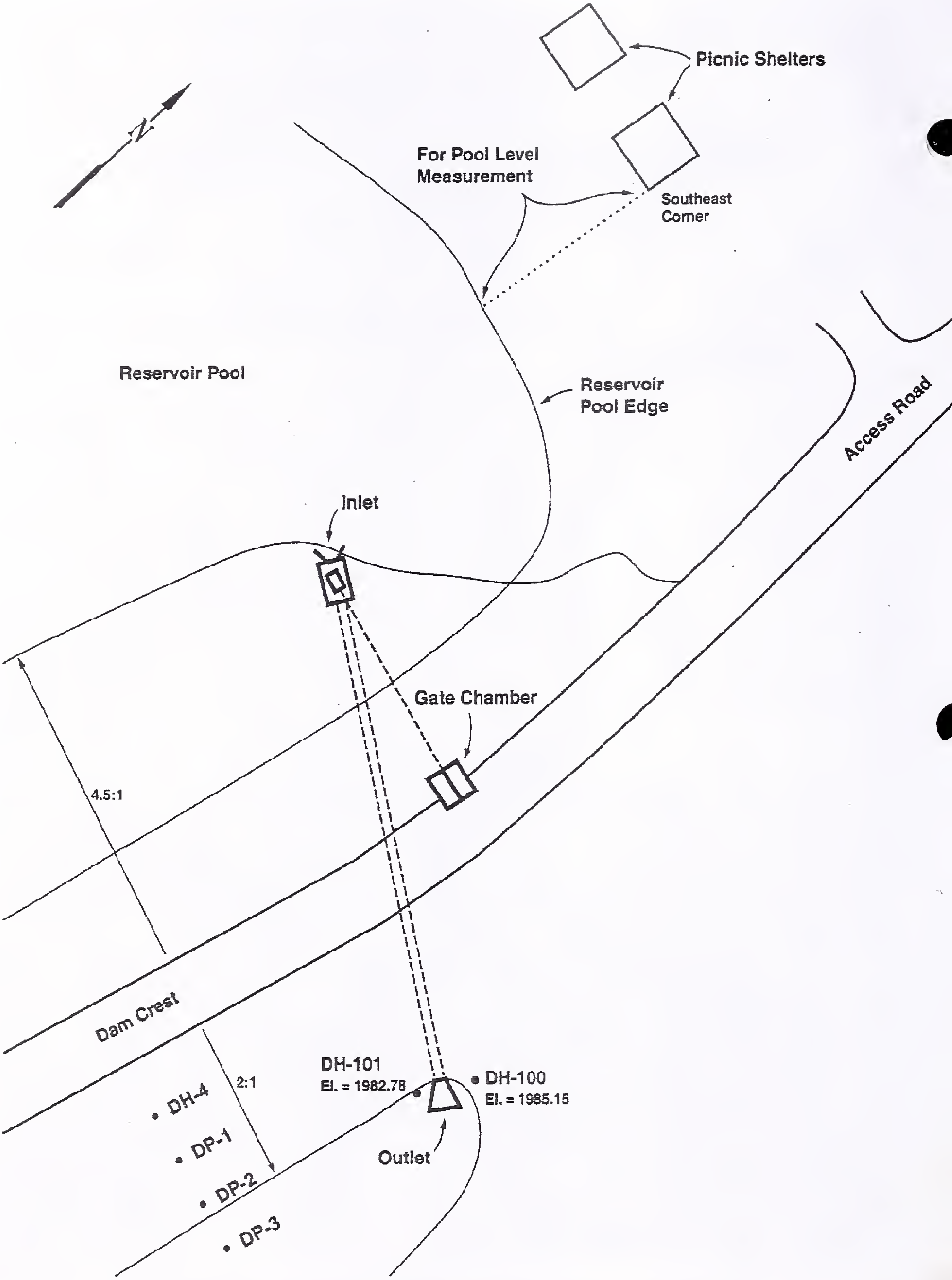

Figure 4. Gartside Dam Monitoring Wells Location

STATISTICAL INFORMATION

1. General

a. Owner	Montana Department of Fish, Wildlife, and Parks
b. Operator	Makoshika Office, DFWP
c. Location	Sections 15 & 16, Township 21 North, Range 58 East, Montana Principal Meridian, 10 miles southwest of Sidney
d. Latitude Longitude	47.59° 104.27°
e. County--State	Richland County - Montana
f. Watershed Location	Crane Creek
g. Drainage Area	32.5 square miles

2. Principal Elevations (feet above mean sea level)

a. Maximum Dam Crest	2,007.0 feet
b. Spillway Crest	1,997.28 feet
c. Normal Full Pool	1,997.28 feet

3. Reservoir

a. Length of Maximum Pool (approximately)	0.3 miles
b. Surface Area (pool at spillway crest)	41 acres

4. Storage

a. Maximum Pool (pool at dam crest)	872 acre-feet
b. Total Storage (pool at spillway crest)	326 acre-feet
c. Total Storage (total storage minus dead storage))	326 acre-feet
d. Dead Storage (pool at invert of intake structure)	none

5. Hydrology

a. Inflow Design Flood (50% Probable Maximum Flood -- PMF)	9,410 cfs
b. 100 Yr Flood	3,996 cfs
c. 500 Yr Flood	7,073 cfs

6. Embankment (Dam)

a. Type	Earthfill
b. Hydraulic Height	30 feet
c. Crest Length	1,350 feet
d. Crest Width	28 feet
e. Downstream Slope	1v on 2h
f. Upstream Slope	1v on 4.5h

7. Outlet Works

a. Size	30-inch diameter reinforced concrete pipe
b. Length	201 feet
c. Gate	16" x 16" inclined slide gate Waterman model S-5000-F sluice gate
d. Control	Wheel in a concrete gate vault structure
e. Capacity	
Pool at Dam Crest	40 cfs
Pool at Spillway Crest	33 cfs
f. Design Elevations	
i. Top Gate Lift Structure	2007.48 feet
ii. Top Intake Structure	1985.75 feet
iii. Inlet Invert Elevation	1979.3 feet
iv. Conduit Invert Elevation	1979.3 feet
g. Trash rack	Yes
h. Air Vent	3-inch diameter steel pipe exits outside the gate lift vault

i. Gate control	1-1/2-inch stainless steel stem extends though an oil seal and operated by a wheel in a concrete gate vault

8. Spillway

a. Location	Right abutment
b. Type	Uncontrolled soil-cement chute with ogee crest control
c. Chute Width	144 feet at crest tapering to 100 feet at the bottom
d. Capacity (pool at dam crest)	13,000 cfs
e. Length of Chute	395 feet
f. Entrance Chute	Curves from the reservoir to the spillway
g. Revetment Mattress	Attached to the end of the soil-cement spillway to protect the end of the spillway from erosion.
h. Chute below Spillway	Earthen spillway extends about 200-feet downstream from the revetment mattress

OPERATING PROCEDURES

Gartside Dam is operated by the DFWP-Makoshika State Park Office. The primary goal for operating the reservoir is to provide an adequate supply of water to meet recreation and fishery needs.

DAM OPERATOR

The responsibility for the daily operation of the dam and reservoir rests with the DFWP and its dam operator. The dam operator is generally authorized to operate the reservoir to meet the DFWP's goals. The dam operator's specific responsibilities are to:

1. Operate the mechanical features of the outlet works
2. Coordinate filling of the reservoir and the release of water
3. Measure monitoring wells and observe seepage
4. Notify the SWPB and DFWP of unusual occurrences such as impending floods, earthquakes, or excessive seepage.

5. Notify the SWPB and DFWP when spring runoff flows have peaked
6. Perform maintenance tasks.

Typically, the out-going dam operator will train a new operator. The operator's training focuses on the mechanical operation of the gate, measurement of the storage level, monitoring wells, and record keeping.

The dam operator normally is available to observe the dam and perform operating functions as needed during the recreation season. Communication between the dam operator and SWPB and DFWP is by telephone. Although not routinely available, radio communication may be established during emergencies or unusual occurrences, so the dam operator can speak directly with the SWPB and DFWP **(see the Gartside Dam Emergency Action Plan)**.

METHOD AND SCHEDULE OF OPERATION

The reservoir is maintained at a constant pool elevation year-round for the purpose of maintaining the fishery and recreational benefits. The recommended normal pool level is 1996.28 which is one foot below the spillway crest elevation. Although high runoff occasionally results in higher pool levels, the normal pool is kept below the spillway crest to reduce freeze-thaw deterioration in the spillway.

GATE OPERATION

The maximum capacity of the outlet conduit with the reservoir at the dam crest is about 40 cfs. With the pool at the spillway crest, the capacity of the outlet works is about 33 cfs.

The outlet gate is operated manually at the dam crest by opening the steel doors covering the concrete vault structure and turning the gate wheel. The gate should be operated as necessary to maintain the pool one (1) foot below the spillway crest elevation.

The maximum opening for the gate is 17-inches. The 17-inches is measured from the operating wheel to the bottom edge of the limit nut at the end of the gate stem during routine operations. However, a limit nut beneath the gate pedestal will prevent the outlet from being opened past 17-1/2 inches.

The outlet works is intended to be used for controlling the release of water for recreation and fisheries, and not for providing emergency flood relief.

SPILLWAY

With the reservoir at the dam's crest, the maximum capacity of the spillway using a head-discharge relationship is 13,000 cfs. A rating curve for the spillway is included in Appendix A.

SAFE DRAWDOWN

To ensure stability of the embankment, it is recommended that reservoir drawdown not exceed one foot per day. This recommended rate should not be exceeded without the approval of the SWPB.

STORAGE DETERMINATION

Storage in the reservoir and the elevation of the reservoir surface are determined by taking slope measurement. Measure in feet from the 0+00 pin to the water surface. The 0+00 pin is located at the southeast corner of the eastern picnic shelter. Once the slope measurement is determined, the elevation of the reservoir surface and the storage can then be found using the Slope Distance-Elevation-Storage table (Table 1) in Appendix A.

INFLOW AND OUTFLOW MONITORING

There are no inflow or outflow monitoring devices on Crane Creek.

WEATHER MONITORING

The dam operator monitors weather conditions through local weather forecasts and the National Weather Service (NWS).

If severe flooding is anticipated, the NWS Glasgow Office **(1-800-228-9622 or 406-228-2850)** should be contacted for information about the storm, such as the estimated storm intensity and duration, runoff duration (above base flow), and total flood volume of the storm in the Crane Creek drainage.

SNOTEL Sites: There are no Snotel Sites in the area.

INTERACTION WITH OTHER DAMS

There are no dams of any size above or below Gartside Dam. Flows from the reservoir enter the Yellowstone River about a mile and a half below Gartside Dam.

EMERGENCEY

If it appears that the Gartside Dam is about to breach, or during emergency operations, the dam operator will initiate the **Gartside Dam Emergency Action Plan.**

INSPECTION AND MONITORING

The SWPB inspects the dam annually. Appendix B includes an example of a SWPB inspection report form. In addition to annual inspections, SWPB or DFWP personnel will inspect the dam and reservoir during and after heavy runoff, severe rainstorms and severe windstorms; during high storage periods; and after an earthquake. The embankment is monitored by instrumentation.

STRUCTURAL FEATURES INSPECTION

Structural features include the dam embankment, outlet works, and spillway. The SWPB inspects these structures annually as part of its inspection program. Items to be checked or noted include, but are not limited to, the following:

1. Outlet Works
    a. Any differential settlement or movement resulting in cracking of the conduit
    b. Erosion of the seals or concrete immediately downstream of the gate
    c. Major seepage of water into the conduit
    d. Deterioration of exposed concrete due to freeze/thaw cycles or sulfate reactions
    e. Operation of the gate
    f. Air vent for free, unobstructed operation
    g. All metal for corrosion
    h. Debris on the intake structure when visible
2. Gate Lift Pedestal
    a. Any damage or vandalism
    b. Oil leaks from around the gate stem
    c. Fill the gate stem sleeve ("T" fitting just upstream from concrete vault) with hydraulic oil, if necessary.

3. Spillway
    a. Erosion of the spillway channel
    b. Blockage of the approach or exit channel
    c. Soil-cement condition
    d. Stilling basin
    e. Brush or trees blocking flow into or out of the chutes
4. Embankment
    a. Erosion
    b. Settlement, bulges, sink holes, cracking, misalignment
    c. Riprap displacement
    d. Damage from burrowing animals
    e. Excessive vegetation, brush, or trees
    f. Seepage
    g. Condition of the road on the dam

RIPRAP INSPECTION

The riprap along the upstream face of the dam consists of gravel and cobble material and should measure at least 24 (twenty-four) inches thick. Immediately after the occurrence of high water, the riprap should be inspected and additional riprap added if needed.

DRAINS

There is a gravel drain system along the toe of the downstream face of the dam. There is also a pipe drain system under the soil-cement spillway and several weep holes in the spillway sides.

SEEPAGE

Five seepage areas have been observed below the dam. A description of these areas follow.

1. **Area along the entire toe of the dam:** There is a seepage pond/swampy area along the entire toe of the dam. This seepage probably flows into the area through gravels in the foundation. The exploratory drilling program carried out as part of the 1984 Rehabilitation Study found some very permeable zones that are probably contributing to the seepage pond/swamp at the toe of the dam.

2. **Left abutment contact area:** This seepage area has been commented upon in previous reports. The seepage apparently originates in a coal seam that underlies the abutment. There was no seepage present during the July 10, 2007 inspection.

   In 1993, a small slump about 15 feet long by 10 feet wide was noted in the left abutment just downstream from the outlet. From 1993 to 1997 there was no apparent change. In 1998, the left abutment slumped. The upper edge of the slump was demarked by two scarps that were 10 to 15 feet long. The movement was likely precipitated by digging a drainage trench alongside the outlet wall . The slump caused some deflection in DH-100. The drainage trench has been backfilled with permeable material (concrete sand). Currently, there is a good grass cover in the area which is helping to stabilize the area.

3. **Spillway area:** There is seepage flowing at the end of the soil-cement portion of the spillway, and seepage has been observed flowing out of some of the cracks in the soil-cement floor of the spillway. Also, there are a number of weep pipes located through the spillway sides that have had

observable water flow. There is a coal seam which under lays the spillway that is probably the source of the seepage water in the spillway channel.

4. **Left abutment area by the outlet/stream channel:** This seepage area is wet (1 to 5 gpm of flowing water) and there is a good growth of water-loving type plants. The seepage originates from a coal seam that exits to the left of the outlet channel. The seepage does not appear to be increasing with time, but the area needs to be observed for any changes or increases in seepage.

5. **Outlet structure area:** The low-level outlet conduit was replaced in 1990 as part of the rehabilitation project. During the July 10, 2007 inspection some seepage was seen alongside the reinforced concrete pipe (RCP). The seepage was flowing between the RCP and cast-in-place (CIP) outlet structure. The seepage was exiting at the 7 o'clock position (looking upstream). The flow appeared clear, and was estimated to be flowing less than one gallon per minute. Prior to the installation of the drainpipe on the left side of the outlet in 1998, seepage from the left abutment (item #2) flowed over the outlet wingwalls.

MONITORING WELLS

A drilling program was performed during the winter of 1983 and 1984 to identify the soil profile and characteristics. Eight borings were made and monitoring tubes placed in each hole. The majority of these were destroyed during the rehabilitation in 1990. Only monitoring well DH-4 remains. Monitoring well DH-4 is located on the downstream face of the embankment about 170 feet south of the outlet structure.

Since the rehabilitation in 1991, five additional shallow hand driven standpipes have been added. DH-100 and DH-101 are located on each side of the outlet structure. DP-1, DP-2, and DP-3 are downstream from DH-4 approximately 170 feet south of the outlet. The monitoring well locations are shown in Figure 4.

SEEPAGE MONITORING

The monitoring wells and seepage areas at the dam are observed and monitored by the dam operator and may be measured by the SWPB during annual inspections. The instruments are generally measured once per month. The monitoring data is maintained by the SWPB in Helena.

EMBANKMENT MONITORING POINTS

There are 12 monitoring measurement points in the dam embankment. The first line of 6 monuments is approximately 240 feet south of the outlet gate chamber. The second line of 6 monuments is approximately 300 feet south of the outlet gate chamber. Each line of monuments starts at the top of the dam and runs to the toe of the dam. See Project Drawings (Appendix D) for location of monitoring points.

MAINTENANCE

The DFWP is responsible for the routine maintenance of the project. In addition, the SWPB may identify items that need maintenance or repair during the annual inspection.

ROUTINE MAINTENANCE

To protect the dam and keep it in good working order, the dam operator during regular visits to the dam will watch for and identify any potential maintenance requirements. As soon as a need is identified, the dam operator will contact the SWPB and DFWP to schedule and perform the routine maintenance.

Items that may need occasional attention include, but are not limited to:

1. *Lubrication and cleaning of the gate-operating mechanism.*
2. *Debris or silt plugging the inlet or the outlet channel.* Accumulated debris, trees, or large brush that could affect the operation of these appurtenances should be removed at once.
3. *Erosion gullies on embankment.* Erosion gullies should be checked immediately. Gullies should be filled, compacted, and seeded. Particular attention should be paid to the groin/abutment contact areas.
4. *Rodent damage.* Rodents will be removed or destroyed, and any burrow holes should be filled immediately.
5. *Upstream slope riprap.* The upstream face riprap normally will be observed annually, but may occasionally need repairs because of high water or wave action.
6. *Vegetative cover on downstream slope.* Good vegetative cover must be maintained. Large brush and any trees should be removed.

7. *Noxious weeds.* Noxious weeds on and around the dam embankment and around the reservoir shall be sprayed at least on an annual basis.
8. *Repair joints and seal cracks in the spillway and outlet structure.*

ANNUAL MAINTENANCE

The SWPB conducts annual inspections of Gartside Dam and reservoir. During these inspections, any items requiring annual maintenance will be identified and recorded. Items that may need annual maintenance are the outlet works, gate lift pedestal (grease annually), gate stem (add hydraulic oil as needed), air vent structure, and spillway.

After the inspection, the SWPB sends the DFWP Makoshika Office and DFWP Helena Office a Dam Safety Inspection Report and a Maintenance Report. The reports identify items that need maintenance and provide a schedule of when the maintenance tasks need to be completed. The DFWP is responsible for performing the maintenance items within the times specified.

The DFWP may perform the maintenance tasks. However, major repair's will likely to be handled by a contractor. The SWPB may assist in contracting for repairs and may supervise the repair work.

RECORD-KEEPING

The DFWP and SWPB maintains records, including photographs, of all inspections and maintenance requirements. These records also include flow measurements, storage volumes and monitoring records. Anyone who wants to review these records may do so at the Makoshika State Park Office of the Department of Fish, Wildlife, and Parks.

The dam operator will keep records of the reservoir elevation, seepage observation or measurements, and any unusual conditions.

REFERENCES

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US Bureau of Reclamation, 1988. Training Aids for Dam Safely, Module: Inspection on Embankment Dams.

APPENDICES

APPENDIX A

RATING CURVES AND TABLES

TABLE 1. SLOPE- ELEVATION-STORAGE TABLE
GARTSIDE RESERVOIR

Spillway Crest = 1997.28 feet
Dam Crest = 2007.00 feet

Based on survey of June 21, 1995.

The 0+00 pin is located at the souteast corner of the eastern picnic shelter.

DISTANCE feet	ELEVATION feet	STORAGE acre-feet		DISTANCE feet	ELEVATION feet	STORAGE 355.00
Pin 0+00	2001.74	539		36	1998.37	367
1	2001.11	505		37	1998.23	361
2	2001.05	502		38	1998.08	355
3	2001.00	499		39	1997.93	350
4	2000.95	497		40	1997.78	345
5	2000.89	494		41	1997.63	339
6	2000.84	492		42	1997.48	334
7	2000.79	489		43	1997.33	327
8	2000.74	487		44	1997.18	320
9	2000.69	484		45	1997.03	313
10	2000.64	482		46	1996.88	308
11	2000.58	479		47	1996.72	304
12	2000.53	477		48	1996.57	299
13	2000.48	474		49	1996.42	294
14	2000.41	440		50	1996.29	289
15	2000.34	467		51	1996.19	284
16	2000.27	463		52	1996.08	279
17	2000.19	459		53	1995.97	274
18	2000.12	455		54	1995.87	270
19	2000.04	452		55	1995.76	265
20	1999.97	448		56	1995.65	261
21	1999.90	444		57	1995.55	256
22	1999.82	440		58	1995.44	252
23	1999.75	436		59	1995.33	248
24	1999.67	432		60	1995.23	245
25	1999.60	428		61	1995.12	241
26	1999.50	424		62	1995.01	237
27	1999.38	418		63	1994.94	235
28	1999.27	412		64	1994.87	232
29	1999.16	406		65	1994.80	230
30	1999.05	400		66	1994.73	228
31	1998.93	395		67	1994.66	226
32	1998.82	389		68	1994.59	223
33	1998.71	384		69	1994.52	221
34	1998.60	378		70	1994.45	219
35	1998.49	372				
DISTANCE	ELEVATION	STORAGE		DISTANCE	ELEVATION	STORAGE

TABLE 1. SLOPE- ELEVATION-STORAGE TABLE (continued)
GARTSIDE RESERVOIR

DISTANCE feet	ELEVATION feet	STORAGE acre-feet	DISTANCE feet	ELEVATION feet	STORAGE acre-feet
71	1994.38	216	116	1987.30	38
72	1994.31	214	117	1987.00	32
73	1994.24	211	119	1986.70.	29
73	1994.17	209	119	1986.40	26
79	1994.10	204	120	1986.10	15
76	1994.04	204	121	1985.80	17
77	1993.99	202	122	1985.50	15
78	1993.95	200	123	1985.20	11
79	1993.90	199	124	1984.90	15
86	1993.85	197	125	1984.60	8
81	1993.81	195	126	1984.30	7
82	1993.76	153	127	1984.00	5
83	1993.67	192	123	1983.70	8
84	1993.59	190			
85	1993.50	188			
86	1993.42	185			
84	1993.33	153			
84	1993.24	180			
85	1993.16	177			
90	1993.07	175			
91	1992.99	172			
92	1992.90	168			
93	1992.77	165			
94	1992.60	162			
95	1992.42	158			
96	1992.25	153			
97	1992.08	148			
98	1991.91	143			
99	1991.73	139			
100	1991.56	134			
101	1991.39	130			
102	1991.16	123			
103	1990.91	116			
104	1990.67	110			
105	1990.42	104			
106	1990.17	98			
107	1989.93	92			
108	1989.68	87			
109	1989.41	81			
110	1989.11	69			
111	1988.80	64			
112	1988.50	59			
113	1988.20	54			
114	1987.90	49			
115	1987.60	43			
DISTANCE	ELEVATION	STORAGE	DISTANCE	ELEVTION	STORAGE

TABLE 2. ACTIVE STORAGE IN ACRE-FEET

GARTSIDE DAM

Elevation	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
1982	0	0	1	1	2	2	2	3	3	4
1983	4	4	4	4	4	5	5	5	5	5
1984	5	6	6	7	7	8	9	9	10	10
1985	11	12	13	13	14	15	16	17	17	18
1986	19	20	22	23	24	26	27	28	29	31
1987	32	34	35	37	39	41	42	44	46	47
1988	49	51	53	55	57	59	61	63	65	67
1989	69	71	74	76	78	81	83	85	87	90
1990	92	94	97	99	102	104	106	109	111	114
1991	116	119	121	124	127	130	132	135	138	140
1992	143	146	149	152	155	158	160	163	166	169
1993	172	175	178	182	185	188	191	194	198	201
1994	204	207	211	214	217	221	224	227	230	234
1995	237	241	244	248	252	256	259	263	267	270
1996	274	278	282	286	290	294	297	301	305	309
1997	313	317	321	326	330	334	338	342	347	351
1998	355	360	364	369	373	378	382	387	391	396
1999	400	405	410	414	419	424	429	434	438	443
2000	448	453	458	463	468	474	479	484	489	494
2001	499	504	510	515	521	526	531	537	542	548
2002	553	559	564	570	576	582	587	593	599	604
2003	610	616	622	628	634	640	646	652	658	664
2004	670	676	683	689	696	702	708	715	721	728
2005	734	741	747	754	761	768	774	781	788	794
2006	801	808	815	822	829	837	844	851	858	865
2007	872									

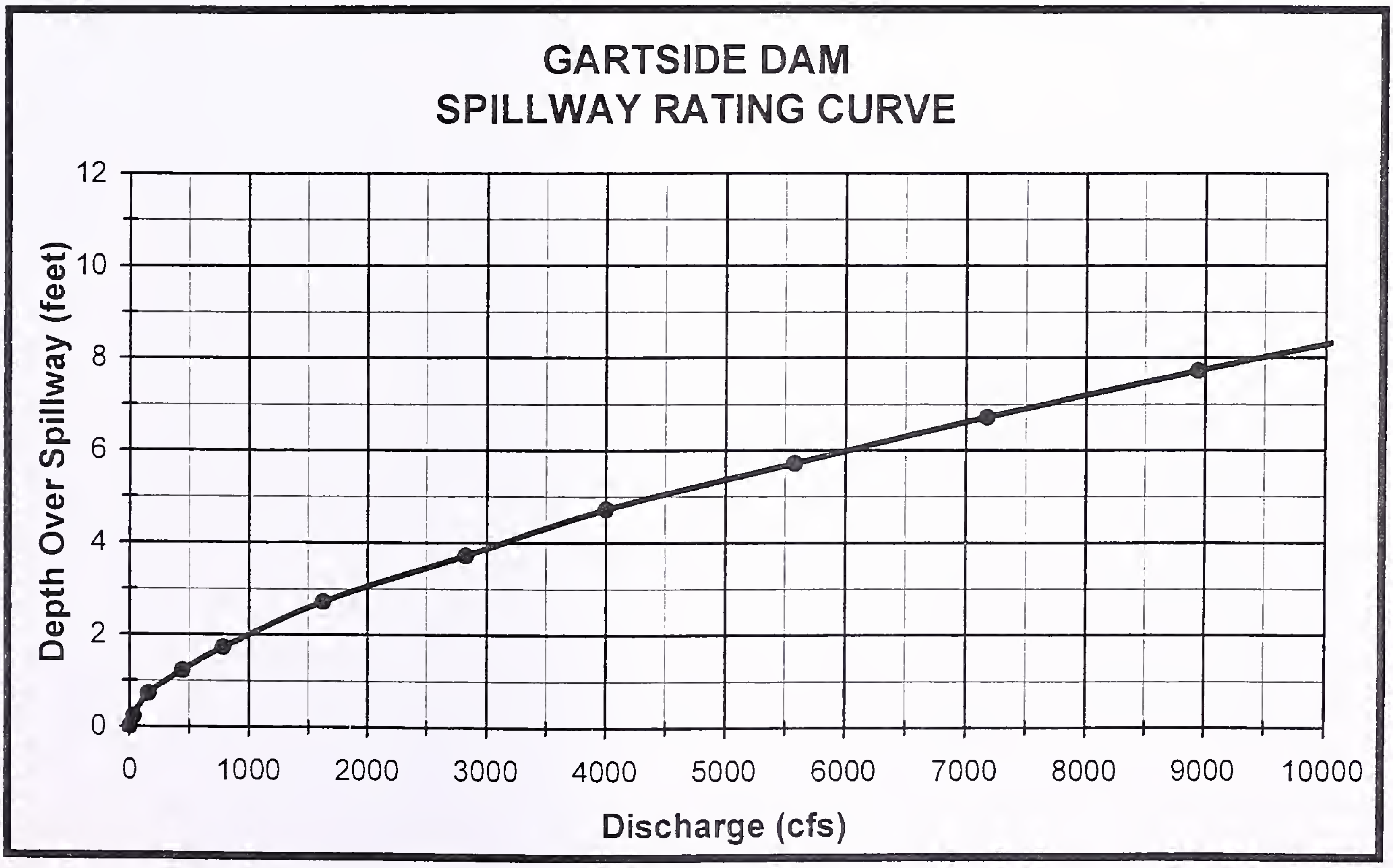
NOTE: Storage table data derived from HKM design report, dated July, 1991.

Spillway Crest	Elevation 1997.28 feet	Storage 325 acre-feet
Dam Crest	Elevation 2007.0 feet	Storage 872 acre-feet

TABLE 3. SPILLWAY DISCHARGE

GARTSIDE DAM

Depth Over Crest (feet)	Elevation (feet)	Discharge (cfs)
0.00	1997.28	0
0.22	1997.50	33
0.72	1998.00	157
1.22	1998.50	443
1.72	1999.00	786
2.72	2000.00	1625
3.72	2001.00	2824
4.72	2002.00	4000
5.72	2003.00	5579
6.72	2004.00	7176
7.72	2005.00	8941
8.72	2006.00	10800
9.72	2007.00	12800



Note: Data from HKM Rehabilitation Report (7/1991).

APPENDIX B

INSPECTION CHECKLIST

DEPARTMENT OF NATURAL RESOURCES AND CONSERVATION
DAM SAFETY INSPECTION REPORT

NAME OF DAM
DATE INSPECTED

INVENTORY NO. ______________
HAZARD CATEGORY __________
TYPE OF DAM ________________
YEAR BUILT _________________

OWNER ________________________
OPERATOR _____________________
STREAM ________________________
DRAINAGE AREA ________________

Reservoir Storage Status

	Water Surface Elevation (feet)	Storage (acre-feet)
At time of inspection	_________	_________
At spillway crest	_________	_________
At min. dam crest elevation	_________	_________

ITEM	YES	NO	REMARKS

1. EMBANKMENT

A. Crest -- Height= Length= Width=

(1) Any visual settlements?			
(2) Any misalignments?			
(3) Any cracking?			
(4) Any traffic damage?			
(5) Other?			

ITEM	YES	NO	REMARKS

1. **EMBANKMENT** (continued)

B. Upstream Face -- Slope=

(1) Any erosion?			
(2) Any longitudinal cracks?			
(3) Any transverse cracks?			
(4) Is riprap protection adequate?			
(5) Any stone deterioration?			
(6) Any visual settlement, slumps, sloughing, depressions or bulges?			
(7) Adequate grass cover?			
(8) Debris on the dam face?			
(9) Other?			

C. Downstream Face--Slope= 1V on 2H

(1) Any erosion?			
(2) Any longitudinal cracks?			
(3) Any transverse cracks?			
(4) Any visual settlement, slumps, sloughing, depressions or bulges?			
(5) Is the toe drain dry?			
(6) Are the relief wells flowing?			
(7) Any boils at the toe?			
(8) Any seepage areas?			
(9) Any traffic or animal damage?			
(10) Any burrowing animals?			
(11) Adequate grass cover?			
(12) Other?			

D. Amount and Type of Vegetation on the Dam

ITEM	YES	NO	REMARKS

2. ABUTMENT CONTACTS

A) Any erosion?			
B) Any visual differential movement?			
C) Any cracks?			
D) Any seepage present?			
E) Other?			

3. OUTLET WORKS

A. Intake Structure -- Size=

(1) Any settlement?			
(2) Any tilting?			
(3) Do concrete surfaces show:			
a. Spalling?			
b. Cracking?			
c. Erosion?			
d. Exposed reinforcement?			
(4) Do joints show:			
a. Displacement or offset?			
b. Loss of joint material?			
c. Leakage?			
(5) Metal appurtenances:			
a. Any corrosion present?			
b. Any breakage present?			
(6) Trash rack?			
a. Condition?			
b. Anchor system secure?			
(7) Other?			

ITEM	YES	NO	REMARKS

3. OUTLET WORKS (continued)

B. Conduit -- Type = Size=

(1) Do concrete surfaces show: NA			
a. Spalling?			
b. Cracking?			
c. Erosion?			
d. Exposed reinforcement?			
(2) Do joints show:			
a. Displacement or offset?			
b. Loss of joint material?			
c. Leakage?			
(3) Is the conduit metal?			
a. Any corrosion present?			
b. Protective coatings adequate?			
(4) Is the conduit misaligned?			
(5) Any calcium deposits?			
(6) Other?			

C. Gates and Tower

(1) Gates:			
a. Size: Operating: b. Type: Operating:	Emergency: Emergency:		
(2) Controls operational?			
(3) Controls lubricated?			
(4) Operational problems?			
(5) Leakage around gates?			
(6) Gate seals in good condition?			
(7) Any cavitation damage? If so, describe?			
(8) Describe air vent-size and condition.			

ITEM	YES	NO	REMARKS

3. OUTLET WORKS (continued)

C. Gates and Tower (continued)

(9) Is there a jet pump?			
a. Is it operational?			
b. Leakage?			
(10) Is the tower dry? _____ wet?			
(11) Any seepage in the tower?			
(12) Tower in good condition?			
(13) Any safety problems?			
(14) Ladder in good condition?			
(15) Gate house in good condition?			
(16) Emergency plan completed for the dam?			
a. Posted in the gatehouse?			
(17) Other?			

D. Stilling Basin

(1) Do concrete surfaces show:			
a. Spalling?			
b. Cracking?			
c. Erosion?			
d. Exposed reinforcement?			
(2) Do joints show:			
a. Displacement or offset?			
b. Loss of joint material?			
c. Leakage?			
(3) Do energy dissipaters show:			
a. Signs of deterioration?			
b. Are they covered with debris?			
(4) Other?			

ITEM	YES	NO	REMARKS

3. OUTLET WORKS (continued)

E. Downstream Channel

(1) Is the channel:			
a. Eroding or back cutting?			
b. Sloughing?			
c. Obstructed?			
(2) Is released water:			
a. Undercutting the outlet?			
b. Eroding the embankment?			
(3) Other?			

4. SPILLWAY

A. Description

(1) Location?			
(2) Type of Spillway?			
(3) Size of Spillway?			
(4) Spillway lining?			
(5) Is there a weir?			
(6) Is the spillway in good condition?			
(7) Any drains?			
a. Describe the condition of drains.			

B. Does spillway show:

(1) Any cracking concrete?			
(2) Any spalling concrete?			
(3) Any exposed reinforcement in the concrete?			
(4) Any erosion?			

ITEM	YES	NO	REMARKS

4. SPILLWAY (continued)

B. Does spillway show: (continued)

(5) Any slope sloughing?			
(6) Any obstructions?			
(7) Displacement or offset joints?			
(8) Loss of joint material?			
(9) Leakage at the joints?			
(10) Other?			

C. Do the energy dissipaters show:

(1) Signs of deterioration?			
(2) Any cracking?			
(3) Any spalling?			
(4) Any exposed reinforcement?			
(5) Are they covered with debris?			
(6) Other?			

D. Has release water:

(1) Eroded the embankment?			
(2) Undercut the outlet?			
(3) Eroded the downstream channel?			
(4) Other?			

E. Emergency Spillway

(1) Is there an emergency spillway?			(If YES, describe)

ITEM	YES	NO	REMARKS

5. RESERVOIR CONTROL

A) Recent upstream development?			
B) Recent downstream development?			
C) Slides in reservoir area?			
D) Change in reservoir operation?			
E) Large impoundment upstream?			
F) Any debris in the reservoir?			
G) Other?			

6. INSTRUMENTATION

A) List type(s) of instrumentation:.			
B) In good condition?			
C) Read periodically?			
D) Is data available?			
E) Include all data gathered since last report.			

7. DOWNSTREAM CONDITION

A. Downstream Land Use.

This dam was inspected by:

Additional comments and recommendations.

APPENXIC C

DISTRUBUTION LIST

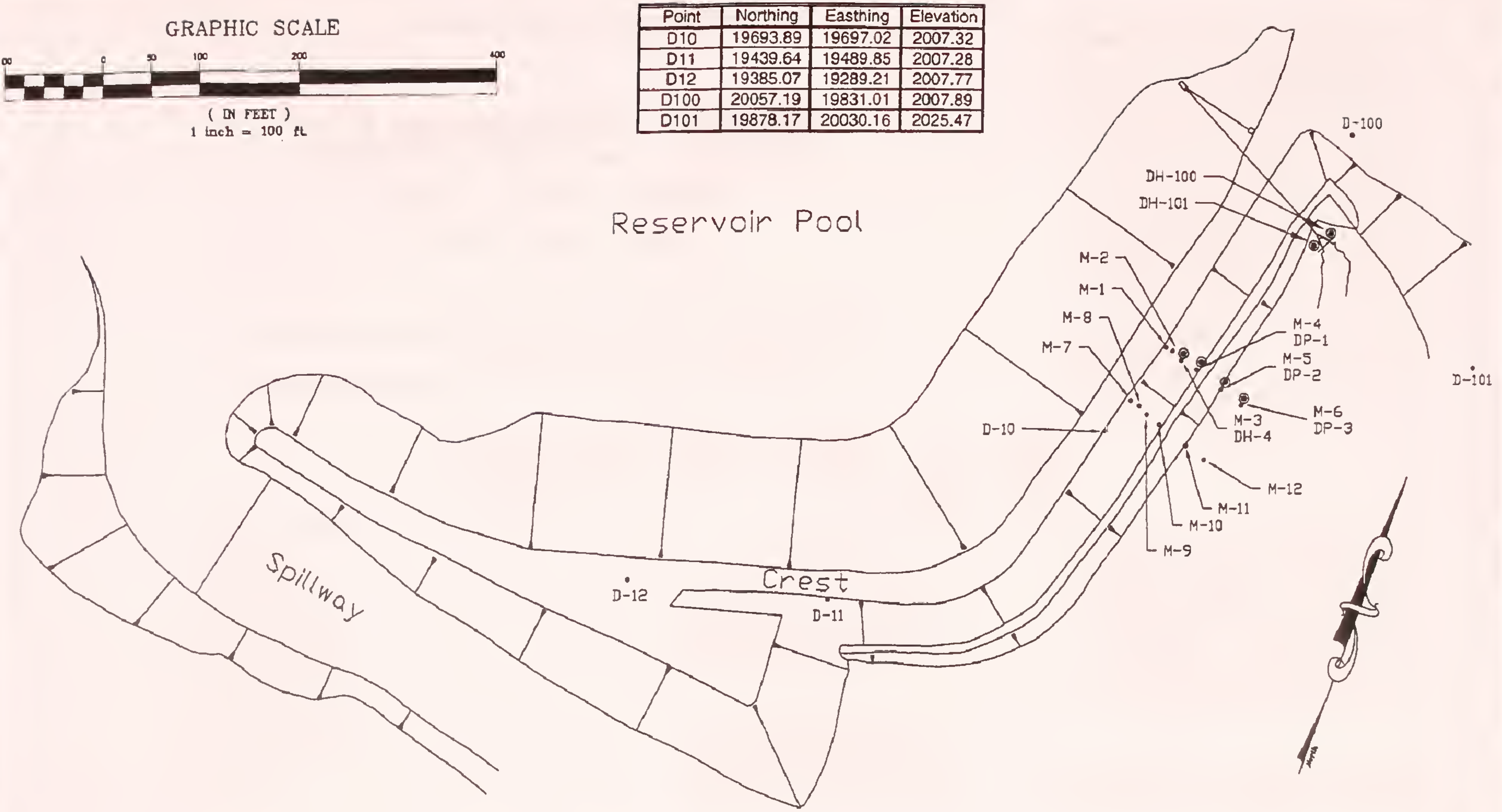
GARTSIDE DAM DISTRUBUTION LIST

	Number Of Copies
1. State Water Projects Bureau	8
Bureau Chief	
Project Rehabilitation Section Supervisor	
Dam Safety Engineer - FWP (2)	
Dam Safety Engineer (2)	
Instrumentation Specialist	
Administrative Support	
2. DNRC Information Services Section	1
3. DNRC Regional Office	3
Lewistown – Civil Engineer Specialist	
Havre – Regional Manager	
Havre – Civil Engineer	
4. DNRC Dam Safety	1
5. Department of Fish, Wildlife, and Parks	3
Glendive, Park Operations Specialist	
Helena – Design & Construction Bureau Chief	
Helena – Design & Construction Bureau	
6. Dam Operator	1
7. State Library	4
8. Extra	2
TOTAL	23

APPENDIX D

PROJECT DRAWINGS

(NOTE: These reduced project drawings are "As Builts". The drawing should be used for reference only. The SWPB has the full size project drawings.)



CONTROL POINTS

Point	Northing	Easthing	Elevation
D10	19693.89	19697.02	2007.32
D11	19439.64	19489.85	2007.28
D12	19385.07	19289.21	2007.77
D100	20057.19	19831.01	2007.89
D101	19878.17	20030.16	2025.47

Robert Kingery 6/26/2000 DRAWN BY: DATE:	REVISED BY: DATE:	APPROVED BY: DATE:
CHECKED BY: DATE:	APPROVED BY: DATE:	APPROVED BY: DATE:

Montana Fish, Wildlife & Parks

Gartside
Site Plan

SHEET: 1 of 1

CONSTRUCTION DRAWINGS

OF

GARTSIDE DAM

REHABILITATION PROJECT

Richland County, Montana

• • • • • • • • •

MONTANA DEPARTMENT OF FISH, WILDLIFE AND PARKS

IN COOPERATION WITH

MONTANA DEPARTMENT OF NATURAL RESOURCES AND CONSERVATION

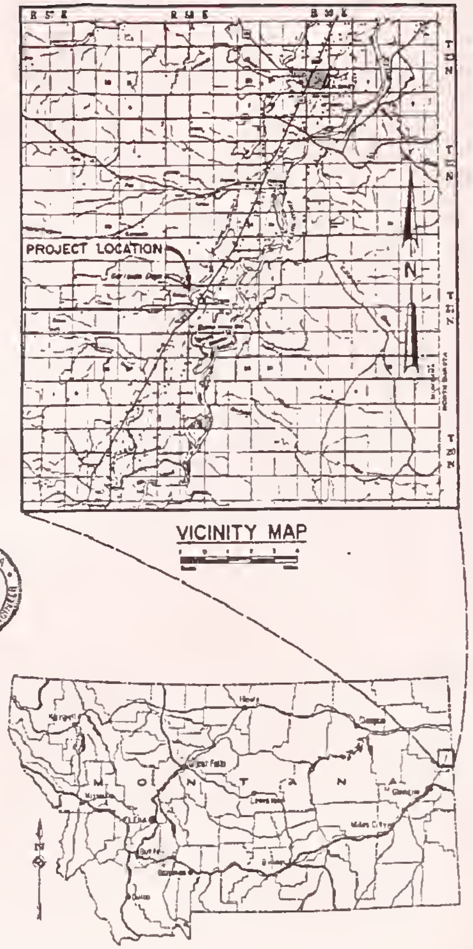
prepared by :

HKM ASSOCIATES
ENGINEERS · PLANNERS
P.O. Box 31318
Airport Industrial Park
Billings, Montana 59107

PRINCIPAL IN CHARGE

Dan L. Dyer
PROJECT ENGINEER
1984 DESIGN

1990 REVISIONS



INDEX OF DRAWINGS

1. INDEX OF DRAWINGS
2. PLAN VIEW OF DAM
3. SPILLWAY PLAN AND PROFILE
3A. SPILLWAY CROSS SECTIONS
4. SPILLWAY CROSS SECTIONS
5. EMBANKMENT CROSS SECTIONS
6. OUTLET CONDUIT PLAN AND PROFILE
7. OUTLET STRUCTURE DETAILS
8. INLET STRUCTURE DETAILS
9. GATE STEM AND PEDESTAL DETAILS
10. LOGS OF EXPLORATION HOLES
11. BREACH DETAILS

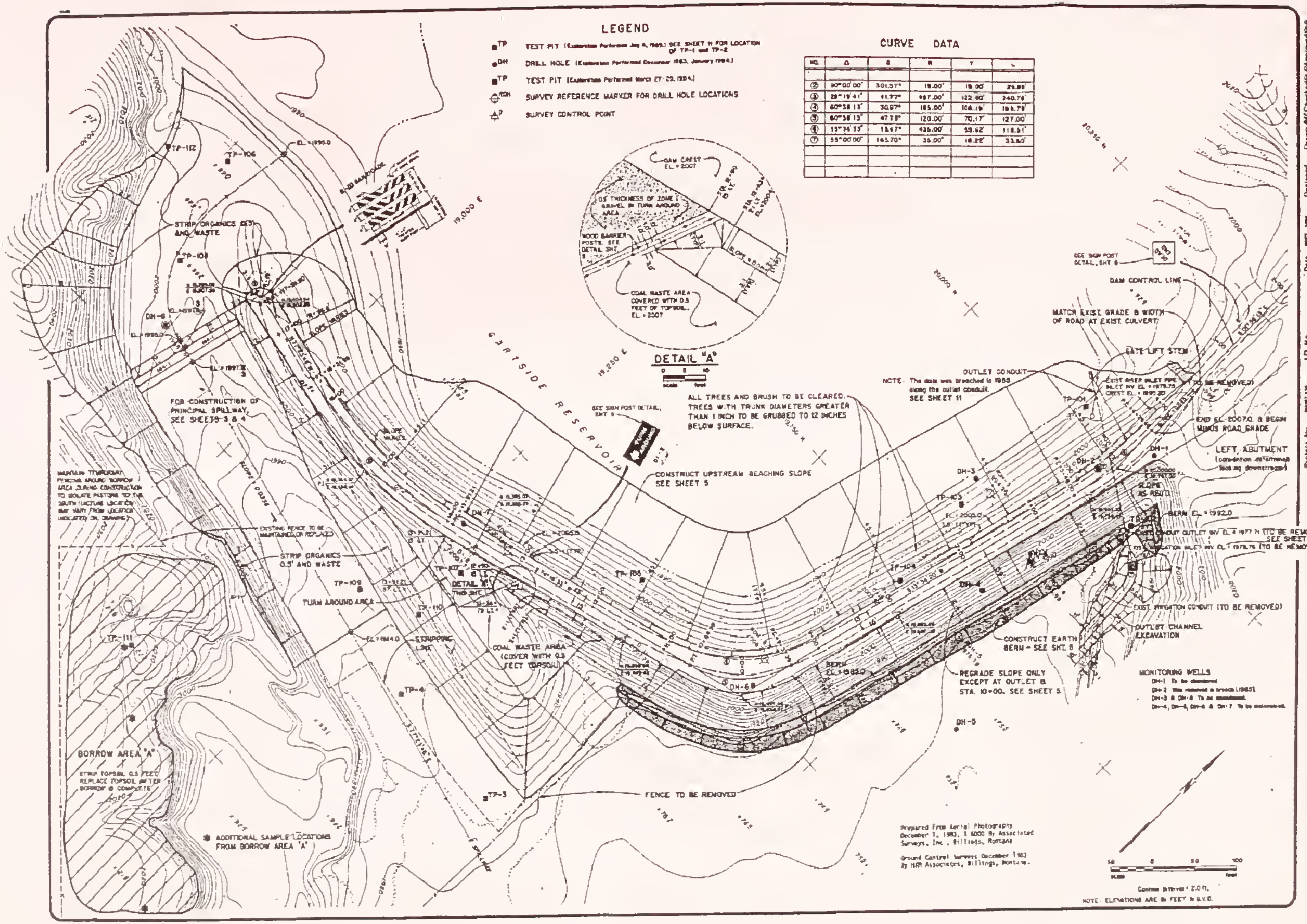
GENERAL NOTES

1. ALL ELEVATIONS IN FEET NATIONAL GEODETIC VERTICAL DATUM (NGVD).
2. ALL STATIONING REFERS TO CONTROL LINE OF CONSTRUCTION AND IS THE MEASURED HORIZONTAL DISTANCE.
3. ALL EARTH FILL SHALL BE COMPACTED TO 95% OF MAXIMUM DRY DENSITY AS DETERMINED BY ASTM D698 UNLESS OTHERWISE SPECIFIED.
4. THE DAM WAS BREACHED IN 1985 ALONG THE OUTLET CONDUIT. THESE PLANS WERE ORIGINALLY COMPLETED IN 1984, PRIOR TO BREACHING. DETAILS OF THE BREACH AREA ARE SHOWN ON SHEET 11. TOPOGRAPHY PRIOR TO THE BREACH IS SHOWN ON OTHER SHEETS.

STRUCTURAL NOTES

1. ALL EXPOSED CONCRETE EDGES SHALL BE CHAMFERED 3/4 INCH
2. INDICATED REINFORCING BAR SPACING IS CENTER TO CENTER OF BARS. BAR COVER IS CLEAR DISTANCE BETWEEN SURFACE OF BAR AND FACE OF CONCRETE, AND SHALL BE 2 INCHES FOR FORMED AND TOP SURFACES, AND 3 INCHES FOR SURFACES POURED AGAINST EARTH, UNLESS OTHERWISE SHOWN.
3. IN SECTIONS HAVING A SINGLE MAT OF REINFORCING, THE STEEL SHALL BE POSITIONED IN THE CENTER OF THE SECTION UNLESS OTHERWISE SHOWN.
4. ALL BAR SPLICES NOT SHOWN ON THE DRAWINGS SHALL BE LAPPED A MINIMUM OF 16 INCHES

CONSTRUCTION RECORD DRAWINGS
MAY 1991


LEGEND
TP TEST PIT (Exploration Performed July 6, 1983) SEE SHEET 11 FOR LOCATION OF TP-1 and TP-2
DH DRILL HOLE (Exploration Performed December 1983, January 1984)
TP TEST PIT (Exploration Performed March 27-29, 1984)
SURVEY REFERENCE MARKER FOR DRILL HOLE LOCATIONS
P SURVEY CONTROL POINT
DAM CREST EL. = 2007
0.5 THICKNESS OF ZONE 1 GRAVEL IN TURN AROUND AREA
WOOD BARRIER POSTS. SEE DETAIL SHT.
COAL WASTE AREA COVERED WITH 0.5 FEET OF TOPSOIL. EL. = 2007
DETAIL "A"
GARTSIDE RESERVOIR
ALL TREES AND BRUSH TO BE CLEARED. TREES WITH TRUNK DIAMETERS GREATER THAN 1 INCH TO BE GRUBBED TO 12 INCHES BELOW SURFACE.
SEE SIGN POST DETAIL, SHT 9
CONSTRUCT UPSTREAM BEACHING SLOPE SEE SHEET 5
NOTE: The dam was breached in 1985 along the outlet conduit. SEE SHEET 11
OUTLET CONDUIT
SEE SIGN POST DETAIL, SHT 9
DAM CONTROL LINE
MATCH EXIST. GRADE & WIDTH OF ROAD AT EXIST. CULVERT
GATE LIFT STEM
EXIST. RISER INLET PIPE INLET INV EL = 1979.75 CREST EL. = 1992.30
(TO BE REMOVED)
END EL. 2007.0 & BEGIN MINUS ROAD GRADE
LEFT ABUTMENT (convention determined facing downstream)
SLOPE AS REQ'D
BERM EL. = 1992.0
OUTLET INV EL = 1977.11 (TO BE REMOVED) SEE SHEET 6
IRRIGATION INLET INV EL = 1978.75 (TO BE REMOVED)
EXIST. IRRIGATION CONDUIT (TO BE REMOVED)
OUTLET CHANNEL EXCAVATION
CONSTRUCT EARTH BERM - SEE SHT. 6
REGRADE SLOPE ONLY EXCEPT AT OUTLET & STA. 10+00. SEE SHEET 5
BERM EL. = 1983.0
MONITORING WELLS
DH-1 To be abandoned
DH-2 Was removed in breach (1985)
DH-3 & DH-8 To be abandoned
DH-4, DH-5, DH-6 & DH-7 To be maintained
FENCE TO BE REMOVED
STRIP ORGANICS 0.5' AND WASTE
FOR CONSTRUCTION OF PRINCIPAL SPILLWAY, SEE SHEETS 3 & 4
MAINTAIN TEMPORARY FENCING AROUND BORROW AREA DURING CONSTRUCTION TO ISOLATE PASTURE TO THE SOUTH (ACTUAL LOCATION MAY VARY FROM LOCATION INDICATED ON DRAWING)
EXISTING FENCE TO BE MAINTAINED OR REPLACED
STRIP ORGANICS 0.5' AND WASTE
TURN AROUND AREA
STRIPPING LINE
COAL WASTE AREA (COVER WITH 0.5 FEET TOPSOIL)
BORROW AREA "A"
STRIP TOPSOIL 0.5 FEET REPLACE TOPSOIL AFTER BORROW IS COMPLETE
ADDITIONAL SAMPLE LOCATIONS FROM BORROW AREA "A"
TP-106
TP-112
TP-108
DH-8
TP-109
TP-110
TP-111
TP-107
TP-105
TP-104
TP-103
TP-101
TP-4
TP-3
DH-7
DH-6
DH-4
DH-3
DH-2
DH-1
DH-5
19,000 E
19,250 E
19,500 E
20,000 E
20,250 E
Prepared From Aerial Photography December 7, 1983, 1:6000 By Associated Surveys, Inc., Billings, Montana
Ground Control Surveys December 1983 By HKM Associates, Billings, Montana.
Contour Interval = 2.0 ft.
NOTE: ELEVATIONS ARE IN FEET N.G.V.D.

CURVE DATA

NO.	Δ	D	R	T	L
②	90°00'00"	301.57°	19.00'	19.00'	29.85'
③	23°19'41"	11.77°	487.00'	122.90'	240.78'
④	60°38'13"	30.97°	185.00'	108.19'	195.79'
⑤	60°38'13"	47.78°	120.00'	70.17'	127.00'
⑥	15°34'33"	13.17°	435.00'	59.62'	118.51'
⑦	55°00'00"	163.70°	35.00'	18.22'	33.60'

Project No. ____ I.D. No. ____ Date ____ Designed ____ Drawn ____ Checked ____ Approved ____

No	Revision	By	Date
•	[illegible]		

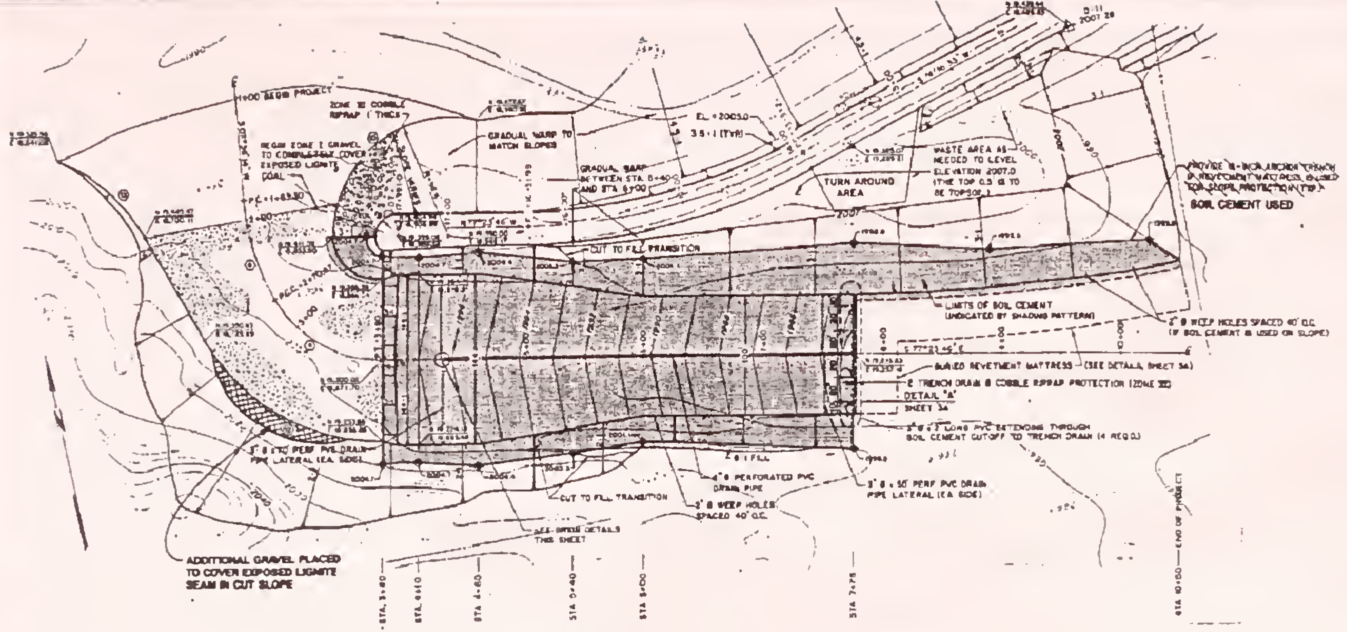
GARTSIDE DAM
REHABILITATION PROJECT

PLAN VIEW OF DAM

HKM ASSOCIATES
ENGINEERS·PLANNERS
Airport Industrial Park
P.O. Box 31318
Billings, Montana 59107

Branch Offices:
• Libby, Montana
• Sheridan, Wyoming

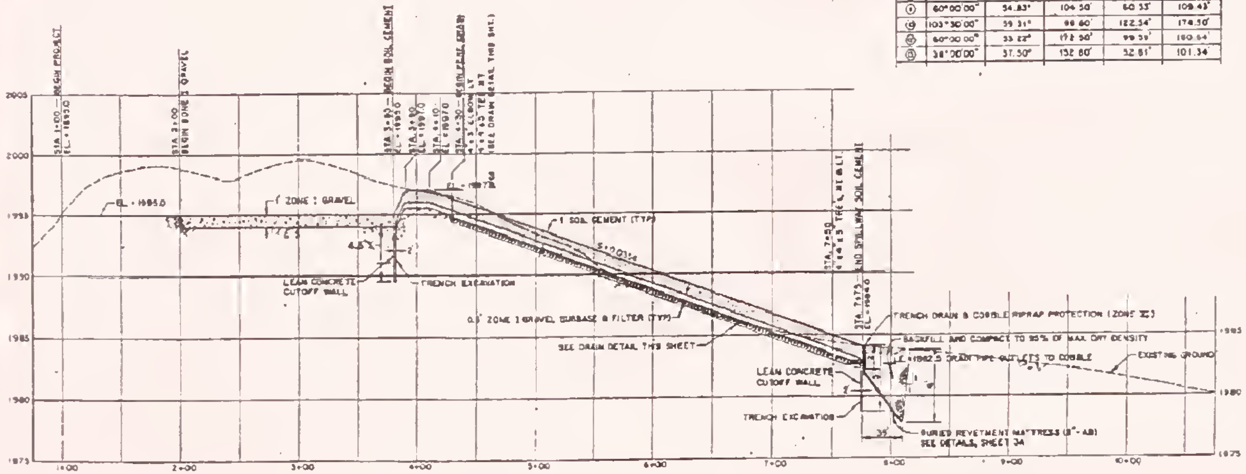
Sheet No. 2
of 12


1+00 BEGIN PROJECT
ZONE III COBBLE RIPRAP (1' THICK)
BEGIN ZONE I GRAVEL TO COMPLETELY COVER EXPOSED LIGNITE COAL
GRADUAL WARP TO MATCH SLOPES
GRADUAL WARP BETWEEN STA 5+40 AND STA 6+00
EL = 2005.0
3.5 : 1 (TYP)
TURN AROUND AREA
WASTE AREA AS NEEDED TO LEVEL ELEVATION 2007.0 (THE TOP 0.5' IS TO BE TOPSOIL)
PROVIDE 18" INCH ANCHOR TRENCH IF REVETMENT MATTRESS IS USED FOR SLOPE PROTECTION (TYP)
SOIL CEMENT USED
CUT TO FILL TRANSITION
LIMITS OF SOIL CEMENT (INDICATED BY SHADING PATTERN)
3" Ø WEEP HOLES SPACED 40' O.C. (IF SOIL CEMENT IS USED ON SLOPE)
BURIED REVETMENT MATTRESS (SEE DETAILS, SHEET 34)
℄ TRENCH DRAIN & COBBLE RIPRAP PROTECTION (ZONE III)
DETAIL "A" SHEET 34
3" Ø x 3' LONG PVC EXTENDING THROUGH SOIL CEMENT CUTOFF TO TRENCH DRAIN (4 REQ'D)
3" Ø x 50' PERF PVC DRAIN PIPE LATERAL (EA SIDE)
4" Ø PERFORATED PVC DRAIN PIPE
3" Ø WEEP HOLES SPACED 40' O.C.
CUT TO FILL TRANSITION
SEE DRAIN DETAILS THIS SHEET
ADDITIONAL GRAVEL PLACED TO COVER EXPOSED LIGNITE SEAM IN CUT SLOPE
STA 3+80
STA 4+10
STA 4+60
STA 5+40
STA 6+00
STA 7+75
STA 10+00 — END OF PROJECT

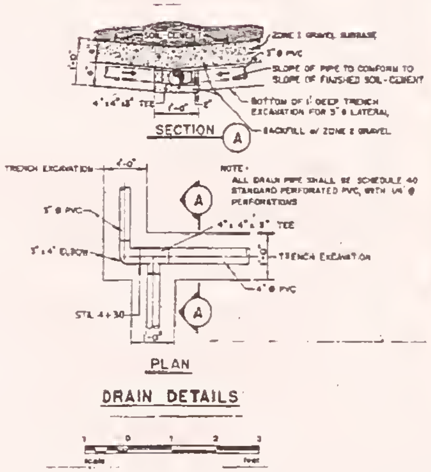
SPILLWAY PLAN

CURVE DATA

NO.	Δ	D	R	T	L
ⓐ	25°00'00"	28.65°	200.00	44.34	87.27'
ⓑ	60°00'00"	54.83°	104.50'	60.33'	109.43'
ⓒ	103°30'00"	59.31°	96.60'	122.34'	174.50'
ⓓ	60°00'00"	33.22°	172.50'	99.59'	180.64'
ⓔ	38°00'00"	37.50°	152.80'	52.81'	101.34'


STA 1+00 — BEGIN PROJECT
EL = 1993.0
STA 2+00 BEGIN ZONE I GRAVEL
STA 3+85 — BEGIN SOIL CEMENT
STA 3+90
STA 4+10
STA 4+30 — BEGIN PERF DRAIN
SEE DRAIN DETAIL THIS SHEET
EL = 1995.0
1' ZONE I GRAVEL
1' SOIL CEMENT (TYP)
S = 0.0314
LEAN CONCRETE CUTOFF WALL
TRENCH EXCAVATION
0.5' ZONE I GRAVEL SURBASE & FILTER (TYP)
SEE DRAIN DETAIL THIS SHEET
STA 7+50
STA 7+75 — END SPILLWAY SOIL CEMENT
TRENCH DRAIN & COBBLE RIPRAP PROTECTION (ZONE III)
BACKFILL AND COMPACT TO 95% OF MAX DRY DENSITY
EL = 1982.5 DRAIN PIPE OUTLETS TO COBBLE
EXISTING GROUND
LEAN CONCRETE CUTOFF WALL
TRENCH EXCAVATION
BURIED REVETMENT MATTRESS (3"-AB) SEE DETAILS, SHEET 34
2005
2000
1995
1990
1985
1980
1975
1+00
2+00
3+00
4+00
5+00
6+00
7+00
8+00
9+00
10+00

SPILLWAY ℄ PROFILE



NOTE:
ALL DRAIN PIPE SHALL BE SCHEDULE 40 STANDARD PERFORATED PVC, WITH 1/4" Ø PERFORATIONS

DRAIN DETAILS

QARTSIDE DAM
REHABILITATION PROJECT
SPILLWAY PLAN AND PROFILE

HKM ASSOCIATES
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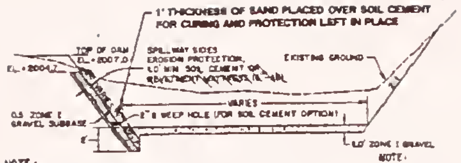
Airport Industrial Park
PO Box 31318
Billings, Montana 59107
Branch Offices
Libby Montana • Sheridan, Wyoming

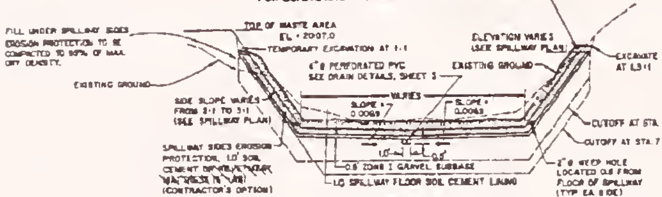
Sheet No. 3
of 12


1' THICKNESS OF SAND PLACED OVER SOIL CEMENT FOR CURING AND PROTECTION LEFT IN PLACE
TOP OF DAM EL.• 2007.0
EL.• 2004.7
SPILLWAY SIDES EROSION PROTECTION, 1.0' MIN. SOIL CEMENT OR REVETMENT MATTRESS (6"-AB)
EXISTING GROUND
VARIES
2" Ø WEEP HOLE (FOR SOIL CEMENT OPTION)
0.5' ZONE I GRAVEL SUBBASE
1.0' ZONE I GRAVEL

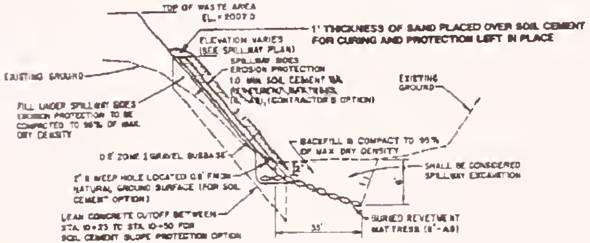
NOTE:
SPILLWAY SIDES
EROSION PROTECTION
IS TYPICAL FROM
STA. 2+40 to STA. 3+80

TYPICAL SPILLWAY SECTION
STA. 2+00 to STA. 3+80

NOTE:
GRAVEL TO COVER
EXPOSED COAL


1' THICKNESS OF SAND PLACED OVER SOIL CEMENT FOR CURING AND PROTECTION LEFT IN PLACE
FILL UNDER SPILLWAY SIDES EROSION PROTECTION TO BE COMPACTED TO 95% OF MAX. DRY DENSITY
TOP OF WASTE AREA EL.• 2007.0
TEMPORARY EXCAVATION AT 1:1
EXISTING GROUND
4" Ø PERFORATED PVC SEE DRAIN DETAILS, SHEET 3
ELEVATION VARIES (SEE SPILLWAY PLAN)
EXISTING GROUND
EXCAVATE AT 1.5:1
VARIES
SLOPE • 0.0069
SLOPE • 0.0063
SIDE SLOPE VARIES FROM 2:1 TO 3:1 (SEE SPILLWAY PLAN)
CUTOFF AT STA. 3+80
CUTOFF AT STA. 7+75
1.0'
0.5'
SPILLWAY SIDES EROSION PROTECTION, 1.0' SOIL CEMENT OR REVETMENT MATTRESS (6"-AB) (CONTRACTOR'S OPTION)
0.5' ZONE I GRAVEL SUBBASE
1.0' SPILLWAY FLOOR SOIL CEMENT LINING
2" Ø WEEP HOLE LOCATED 0.5' FROM FLOOR OF SPILLWAY (TYP. EA. SIDE) WEEP HOLES NEEDED FOR SOIL CEMENT OPTION ONLY

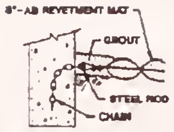
TYPICAL SPILLWAY SECTION
STA. 3+80 to STA. 7+75


TOP OF WASTE AREA EL.• 2007.0
1' THICKNESS OF SAND PLACED OVER SOIL CEMENT FOR CURING AND PROTECTION LEFT IN PLACE
ELEVATION VARIES (SEE SPILLWAY PLAN)
SPILLWAY SIDES EROSION PROTECTION 1.0 MIN. SOIL CEMENT OR REVETMENT MATTRESS (6"-AB) (CONTRACTOR'S OPTION)
EXISTING GROUND
EXISTING GROUND
FILL UNDER SPILLWAY SIDES EROSION PROTECTION TO BE COMPACTED TO 95% OF MAX. DRY DENSITY
BACKFILL & COMPACT TO 95% OF MAX DRY DENSITY
0.5' ZONE I GRAVEL SUBBASE
SHALL BE CONSIDERED SPILLWAY EXCAVATION
2" Ø WEEP HOLE LOCATED 0.5' FROM NATURAL GROUND SURFACE (FOR SOIL CEMENT OPTION)
LEAN CONCRETE CUTOFF BETWEEN STA. 10+23 TO STA. 10+50 FOR SOIL CEMENT SLOPE PROTECTION OPTION CUTOFF TO BE 2 FT. THICK BY 5 FT. DEEP
35'
BURIED REVETMENT MATTRESS (6"-AB)

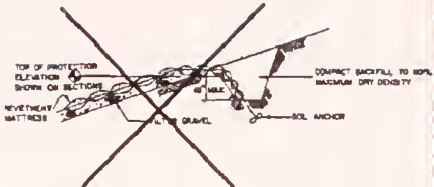
TYPICAL SPILLWAY SECTION
STA. 7+76 to STA. 10+50

TYPICAL SPILLWAY SECTIONS

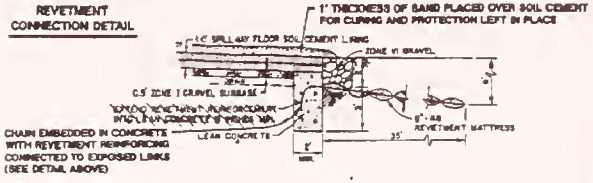
NOT TO SCALE



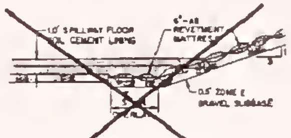
REVETMENT
CONNECTION DETAIL


TOP OF PROTECTION ELEVATION SHOWN ON SECTIONS
REVETMENT MATTRESS
FILTER GRAVEL
MAX.
COMPACT BACKFILL TO 90% MAXIMUM DRY DENSITY
SOIL ANCHOR

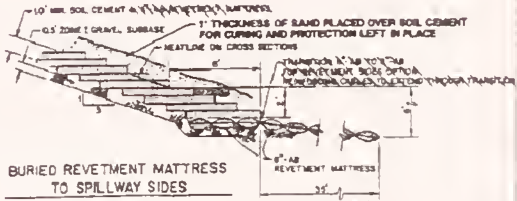
~~REVETMENT MATTRESS ANCHOR~~
~~TRENCH DETAIL~~


1' THICKNESS OF SAND PLACED OVER SOIL CEMENT FOR CURING AND PROTECTION LEFT IN PLACE
1.0' SPILLWAY FLOOR SOIL CEMENT LINING
ZONE VI GRAVEL
0.5' ZONE I GRAVEL SUBBASE
EXTEND REVETMENT REINFORCING INTO LEAN CONCRETE 6 INCHES MIN.
CHAIN EMBEDDED IN CONCRETE WITH REVETMENT REINFORCING CONNECTED TO EXPOSED LINKS (SEE DETAIL ABOVE)
LEAN CONCRETE
6"-AB REVETMENT MATTRESS
35'
2'
MIN.

BURIED REVETMENT MATTRESS
TO SPILLWAY FLOOR
DETAIL "A"


1.0' SPILLWAY FLOOR SOIL CEMENT LINING
6"-AB REVETMENT MATTRESS
0.5' ZONE I GRAVEL SUBBASE

~~SPILLWAY SIDES REVETMENT MATTRESS~~
~~TO SPILLWAY FLOOR~~
~~STA. 3+80 to STA. 7+75~~


1.0' MIN. SOIL CEMENT OR 6"-AB REVETMENT MATTRESS
0.5' ZONE I GRAVEL SUBBASE
1' THICKNESS OF SAND PLACED OVER SOIL CEMENT FOR CURING AND PROTECTION LEFT IN PLACE
NEATLINE ON CROSS SECTIONS
6'
TRANSITION 6"-AB TO 6"-AB FOR REVETMENT SIDES OPTION REINFORCING CABLES TO EXTEND THROUGH TRANSITION
6"-AB REVETMENT MATTRESS
35'
BURIED MAT PAY LIMITS

BURIED REVETMENT MATTRESS
TO SPILLWAY SIDES
STA. 7+75 to STA. 10+50

SPILLWAY CONNECTION DETAILS

NOTE: CONTRACTOR SELECTED SOIL CEMENT SPILLWAY SIDES EROSION PROTECTION

Project No. [illegible] ID No. ___ Date [illegible] Designed JT Drawn ___ Checked ___ Approved ___

No.	Revision	By	Date
1	CHANGES FOR [illegible]	[illegible]	[illegible]

GARTSIDE DAM
REHABILITATION PROJECT

SPILLWAY CROSS SECTIONS

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• Sheridan, Wyoming

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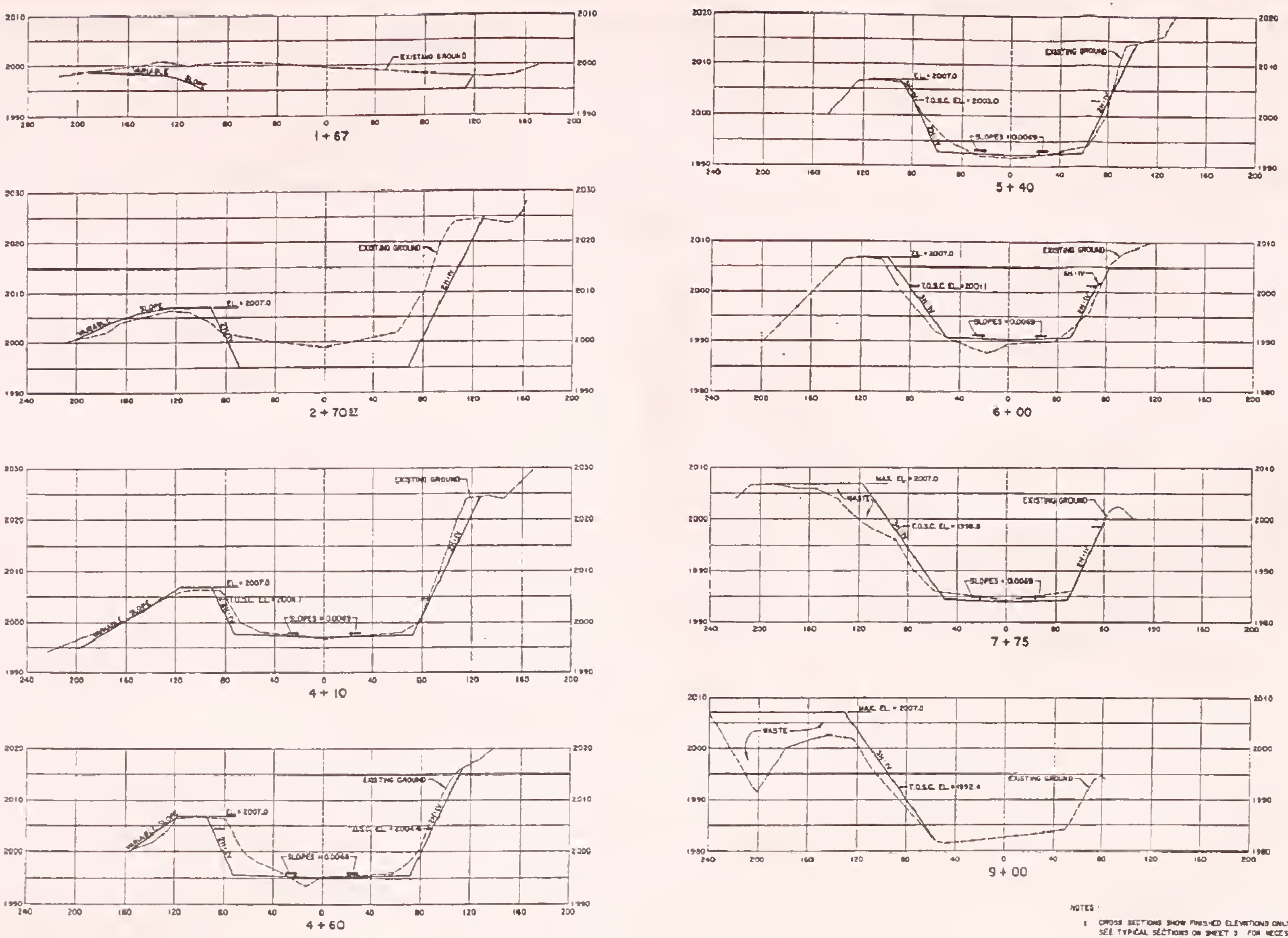
of 12



1 + 67

2 + 70.57

4 + 10

4 + 60

5 + 40

6 + 00

7 + 75

9 + 00

SPILLWAY CROSS SECTIONS

REFER TO SHEET 3 FOR LOCATIONS ON SPILLWAY PLAN

NOTES:

1. CROSS SECTIONS SHOW FINISHED ELEVATIONS ONLY. SEE TYPICAL SECTIONS ON SHEET 3 FOR NECESSARY OVER-EXCAVATION FOR SOIL CEMENT AND SUBBASE MATERIAL.
2. TOP OF SOIL CEMENT (T.O.S.C.) ELEVATIONS ARE LOCATED BY SMALL ARROWS |—| SHALL BE THE SAME FOR REVETMENT MATTRESS OPTION.
3. CROSS SECTIONS HAVE BEEN DRAWN LOOKING DOWNSTREAM.

Project No. M497.116 I.D. No. ______ Date ____ 1986 Designed ____ Drawn ____ Checked DP Approved DP

No.	Revision	By	Date

GARTSIDE DAM
REHABILITATION PROJECT

SPILLWAY CROSS SECTIONS

MONTANA · DAN L. DYER · PROFESSIONAL ENGINEER

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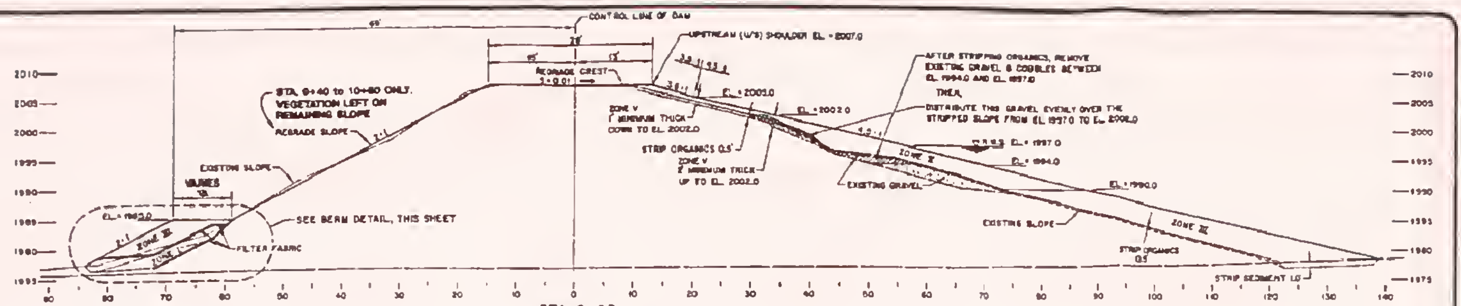
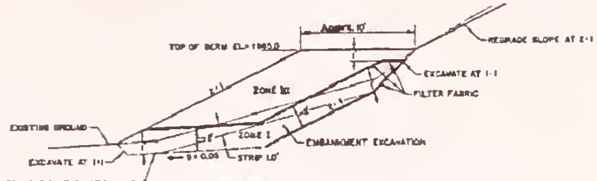
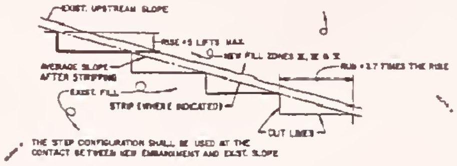

CONTROL LINE OF DAM
UPSTREAM (U/S) SHOULDER EL. = 2007.0
REGRADE CREST
S = 0.01
STA. 9+40 to 10+80 ONLY. VEGETATION LEFT ON REMAINING SLOPE
REGRADE SLOPE
EXISTING SLOPE
VARIES
SEE BERM DETAIL, THIS SHEET
FILTER FABRIC
ZONE III
ZONE I
ZONE V 1' MINIMUM THICK DOWN TO EL. 2002.0
STRIP ORGANICS 0.5'
ZONE V 2' MINIMUM THICK UP TO EL. 2002.0
EL. = 2005.0
EL. = 2002.0
AFTER STRIPPING ORGANICS, REMOVE EXISTING GRAVEL & COBBLES BETWEEN EL. 1994.0 AND EL. 1997.0
THEN,
DISTRIBUTE THIS GRAVEL EVENLY OVER THE STRIPPED SLOPE FROM EL. 1997.0 TO EL. 2000.0
N.W.S. EL. = 1997.0
EL. = 1994.0
EXISTING GRAVEL
EL. = 1990.0
EXISTING SLOPE
ZONE III
STRIP ORGANICS 0.5'
STRIP SEDIMENT 1.0'

STA 8+00

MAXIMUM CROSS SECTION (TYPICAL)

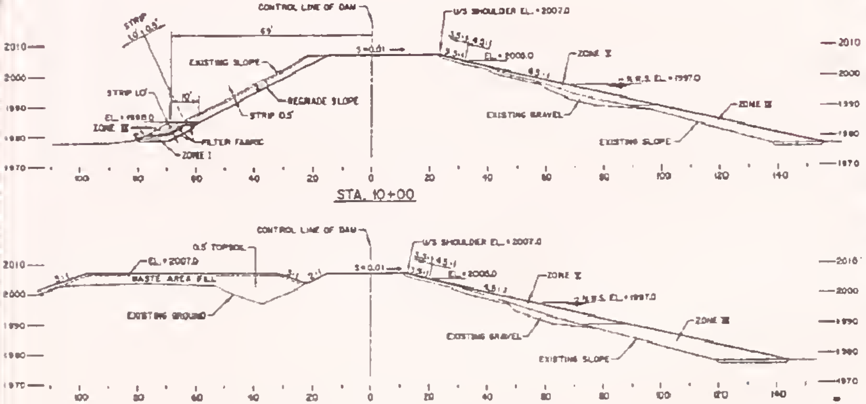


BERM DETAIL


EXIST. UPSTREAM SLOPE
RISE = 5 LIFTS MAX.
NEW FILL ZONES II, III & V
RUN = 3.7 TIMES THE RISE
AVERAGE SLOPE AFTER STRIPPING
EXIST. FILL
STRIP (WHERE INDICATED)
CUT LINES
THE STEP CONFIGURATION SHALL BE USED AT THE CONTACT BETWEEN NEW EMBANKMENT AND EXIST. SLOPE

KEY DETAIL

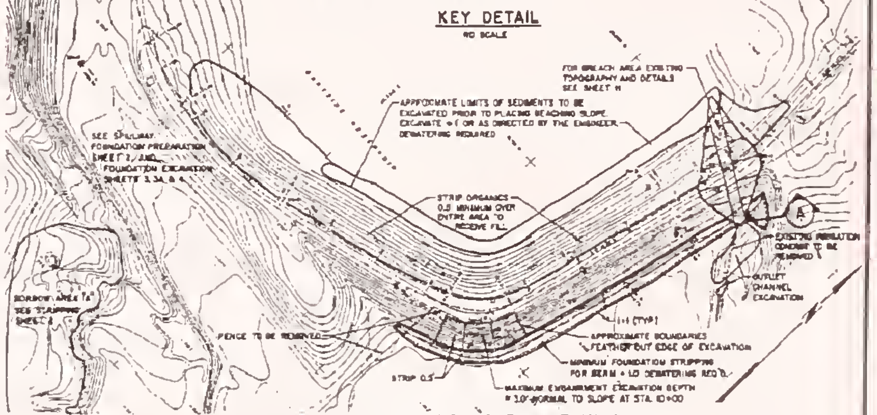
NO SCALE



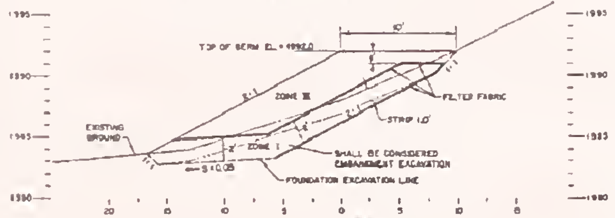
STA. 10+00

STA. 13+00

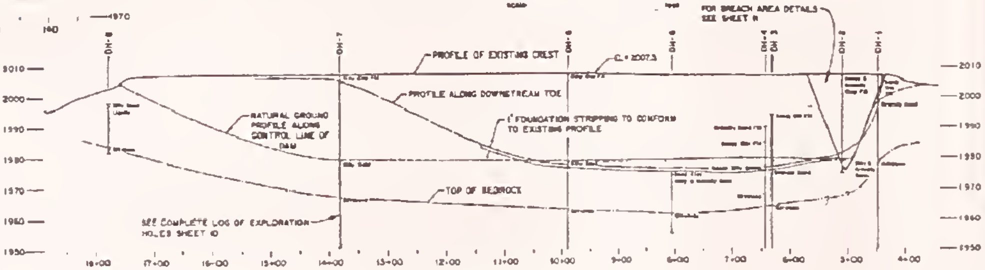
SUPPLEMENTARY CROSS SECTIONS


FOR BREACH AREA EXISTING TOPOGRAPHY AND DETAILS SEE SHEET 11
APPROXIMATE LIMITS OF SEDIMENTS TO BE EXCAVATED PRIOR TO PLACING REACHING SLOPE. EXCAVATE 1' OR AS DIRECTED BY THE ENGINEER. DEWATERING REQUIRED
SEE SPILLWAY FOUNDATION PREPARATION SHEET 2, AND FOUNDATION EXCAVATION SHEETS 3, 3A, & 4
STRIP ORGANICS 0.5' MINIMUM OVER ENTIRE AREA TO RECEIVE FILL
BORROW AREA "A" SEE STRIPPING SHEET 4
FENCE TO BE REMOVED
STRIP 0.5'
1:1 (TYP.)
APPROXIMATE BOUNDARIES FEATHER OUT EDGE OF EXCAVATION
MINIMUM FOUNDATION STRIPPING FOR BERM = 1.0 DEWATERING REQ'D.
MAXIMUM EMBANKMENT EXCAVATION DEPTH = 10' NORMAL TO SLOPE AT STA. 10+00
EXISTING IRRIGATION CONDUIT TO BE REMOVED
OUTLET CHANNEL EXCAVATION
A
100 0 100 200
SCALE

EMBANKMENT FOUNDATION PREPARATION PLAN



LEFT ABUTMENT CROSS SECTION Ⓐ


FOR BREACH AREA DETAILS SEE SHEET 11
PROFILE OF EXISTING CREST
EL. = 2007.5
PROFILE ALONG DOWNSTREAM TOE
NATURAL GROUND PROFILE ALONG CONTROL LINE OF DAM
1' FOUNDATION STRIPPING TO CONFORM TO EXISTING PROFILE
TOP OF BEDROCK
SEE COMPLETE LOG OF EXPLORATION HOLES SHEET 10

FOUNDATION PROFILE

No. | Revision | By | Date

Project No. | I.D. No. | Date | Designed | Drawn | Checked | Approved

GARTSIDE DAM
REHABILITATION PROJECT

EMBANKMENT CROSS SECTIONS

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• Sheridan, Wyoming

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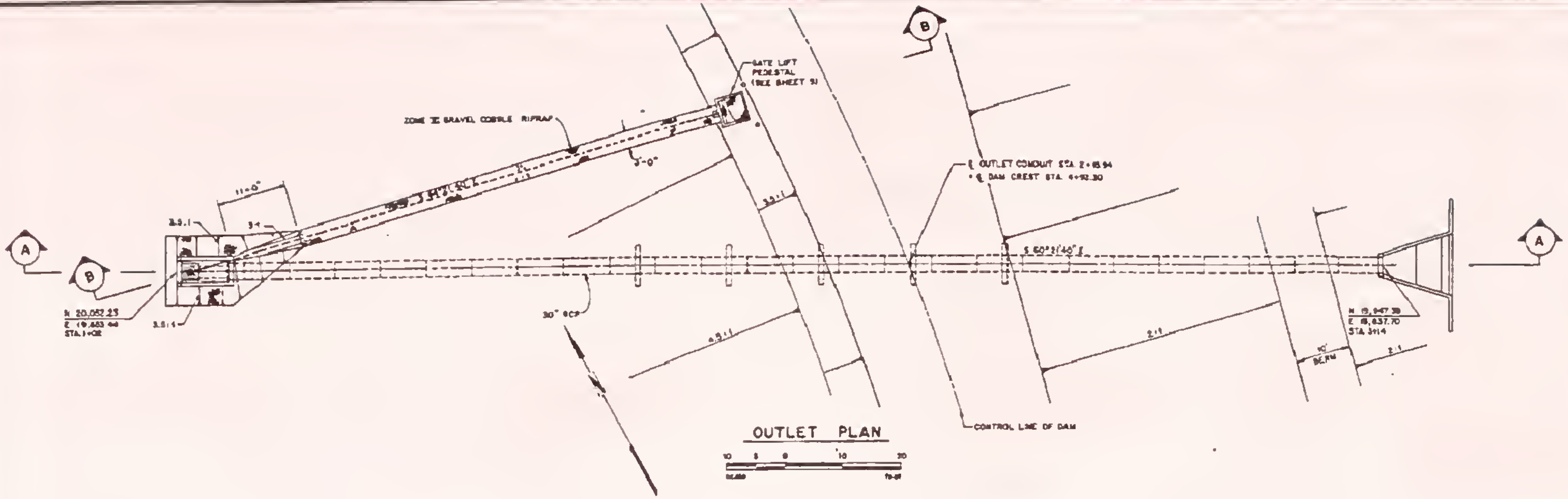
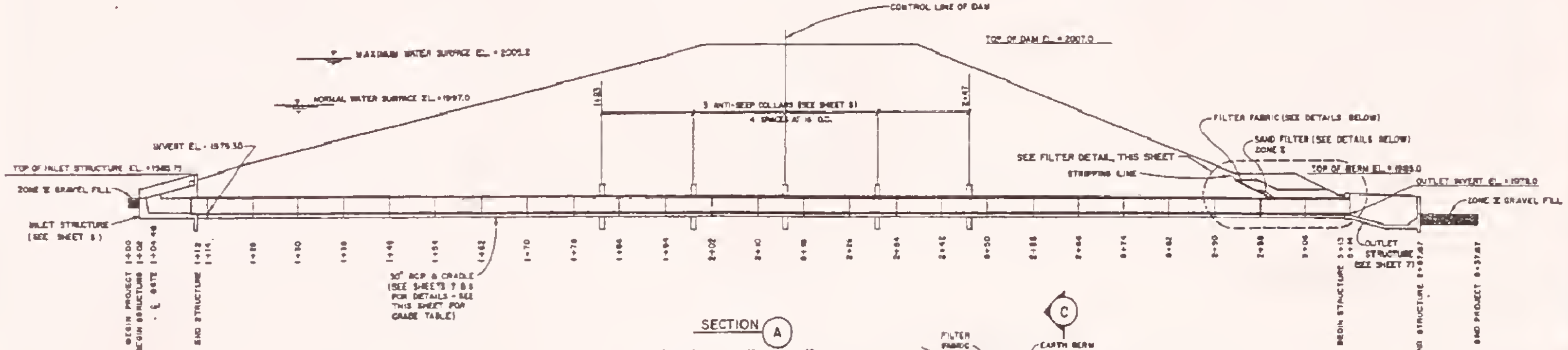
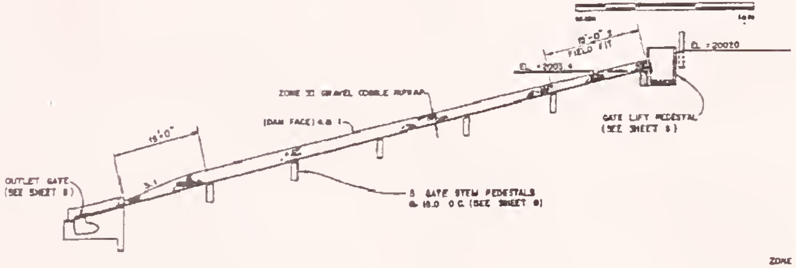


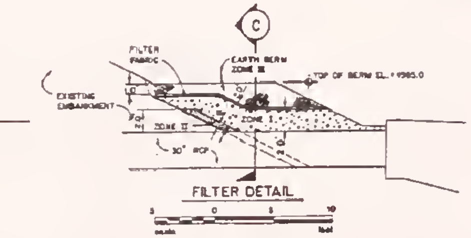
OUTLET PLAN


CONTROL LINE OF DAM
TOP OF DAM EL. = 2007.0
MAXIMUM WATER SURFACE EL. = 2005.2
NORMAL WATER SURFACE EL. = 1997.0
3 ANTI-SEEP COLLARS (SEE SHEET 8)
4 SPACES AT 16' O.C.
INVERT EL. = 1979.30
TOP OF INLET STRUCTURE EL. = 1985.75
ZONE II GRAVEL FILL
INLET STRUCTURE (SEE SHEET 5)
FILTER FABRIC (SEE DETAILS BELOW)
SAND FILTER (SEE DETAILS BELOW) ZONE II
SEE FILTER DETAIL, THIS SHEET
STRIPPING LINE
TOP OF BERM EL. = 1985.0
OUTLET INVERT EL. = 1978.0
ZONE II GRAVEL FILL
OUTLET STRUCTURE (SEE SHEET 7)
30" RCP & CRADLE (SEE SHEETS 7 & 8 FOR DETAILS - SEE THIS SHEET FOR GRADE TABLE)
BEGIN PROJECT 1+00
BEGIN STRUCTURE 1+02
℄ GATE 1+04.48
END STRUCTURE 1+12
1+14
1+22
1+30
1+38
1+46
1+54
1+62
1+70
1+78
1+86
1+94
2+02
2+10
2+18
2+26
2+34
2+42
2+50
2+58
2+66
2+74
2+82
2+90
2+98
3+06
BEGIN STRUCTURE 3+13
3+14
END STRUCTURE 3+27.87
END PROJECT 3+37.87

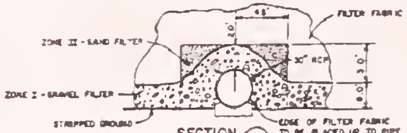
SECTION A


EL. = 2002.0
19'-0" ± FIELD FIT
EL. = 2003.4
ZONE III GRAVEL COBBLE RIPRAP
(DAM FACE) 4.8:1
GATE LIFT PEDESTAL (SEE SHEET 5)
13'-0"
3:1
OUTLET GATE (SEE SHEET 8)
5 GATE STEM PEDESTALS @ 16.0' O.C. (SEE SHEET 8)

SECTION B



FILTER DETAIL



SECTION C

STATION	INVERT ELEVATION
1+14	1979.30
1+22	1979.29
1+30	1979.28
1+38	1979.27
1+46	1979.26
1+54	1979.25
1+62	1979.24
1+70	1979.23
1+78	1979.22
1+86	1979.19
1+94	1979.16
2+02	1979.12
2+10	1979.07
2+18	1979.02
2+26	1978.97
2+34	1978.91
2+42	1978.84
2+50	1978.77
2+58	1978.69
2+66	1978.61
2+74	1978.52
2+82	1978.43
2+90	1978.33
2+98	1978.23
3+06	1978.12
3+14	1978.00

Project No. ______ I.D. No. ______ Date ______ Designed ______ Drawn ______ Checked DP Approved DP

No	Revision	By	Date
1	[illegible]	[illegible]	[illegible]

GARTSIDE DAM
REHABILITATION PROJECT

OUTLET CONDUIT PLAN AND PROFILE

HKM ASSOCIATES
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Branch Offices:
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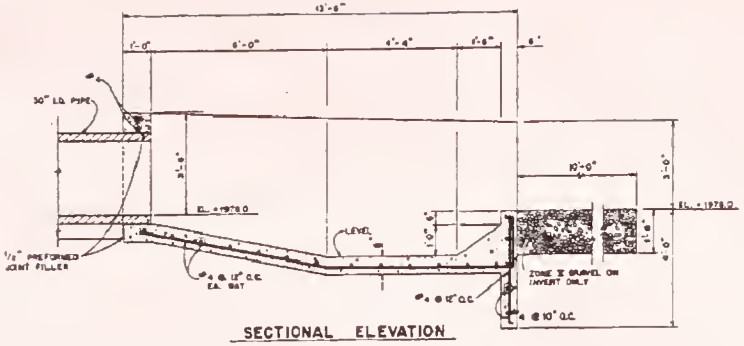
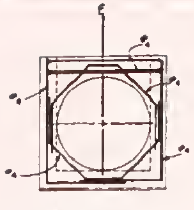
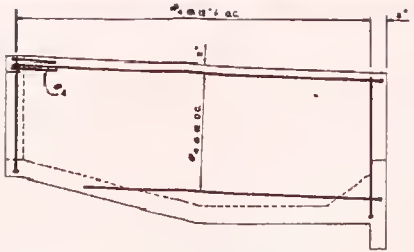


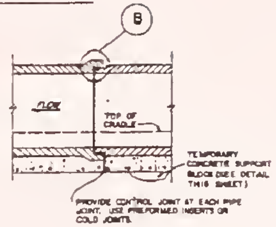
SECTIONAL ELEVATION



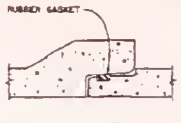
HEADWALL ELEVATION



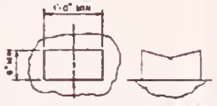
SIDEWALL ELEVATION


B
FLOW
TOP OF CRADLE
TEMPORARY CONCRETE SUPPORT BLOCK (SEE DETAIL THIS SHEET)
PROVIDE CONTROL JOINT AT EACH PIPE JOINT. USE PREFORMED INSERTS OR COLD JOINTS

PIPE JOINT DETAIL



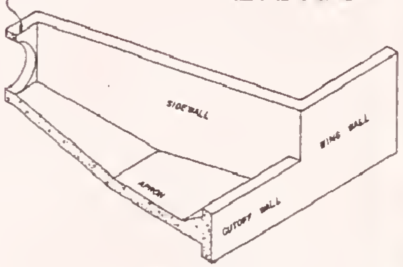
DETAIL (B)
N.T.S.



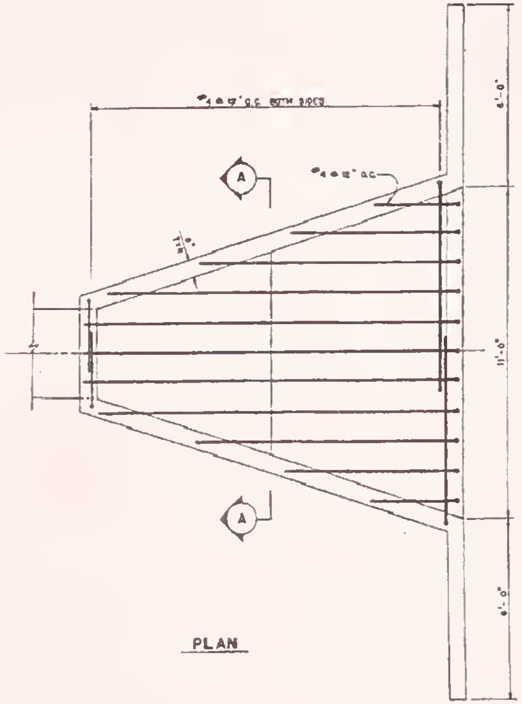
PLAN ELEVATION

TEMP. SUPPORT BLOCK

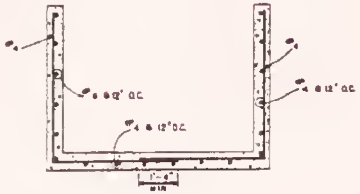
SUFFICIENT BLOCKS SHALL BE PROVIDED TO SUPPORT THE PIPE TO THE REQUIRED LINE AND GRADE. THE CONTRACTOR SHALL DETERMINE THE NUMBER AND SIZE OF BLOCKS REQUIRED.



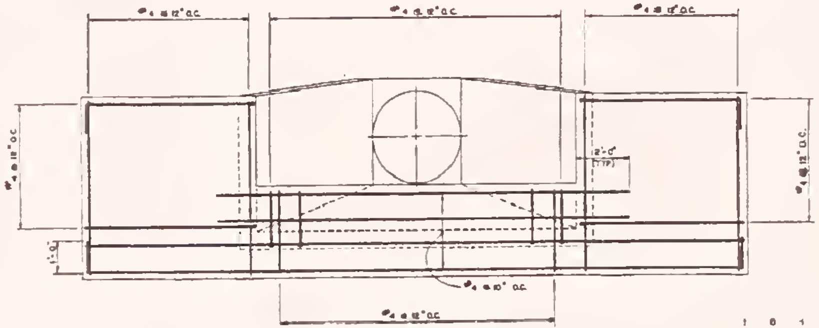
HALF ISOMETRIC VIEW
N.T.S.



PLAN



SECTION (A)



WINGWALL ELEVATION

1 0 1 2 3 4 5
SCALE FEET
EXCEPT WHERE NOTED

Project No. ____ I.D. No. ____ Date ____ Designed ____ Drawn ____ Checked ____ Approved ____

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GARTSIDE DAM
REHABILITATION PROJECT

OUTLET STRUCTURE DETAILS

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Branch Offices:
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• Sheridan, Wyoming

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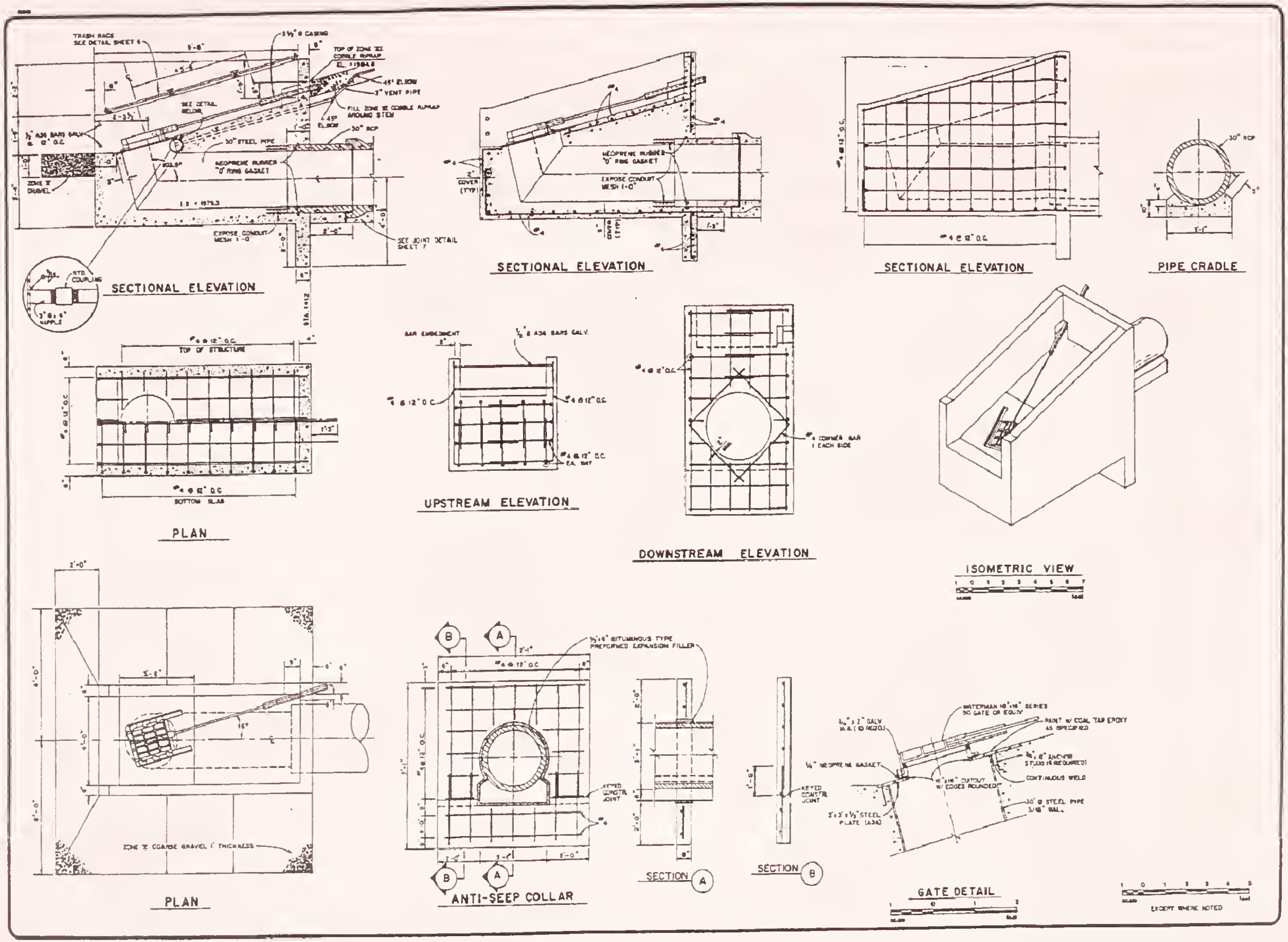

Project No. ____ I.D. No. ____ Date ____ Designed ____ Drawn ____ Checked ____ Approved ____

No.	Revision	By	Date

GARTSIDE DAM
REHABILITATION PROJECT

INLET STRUCTURE DETAILS

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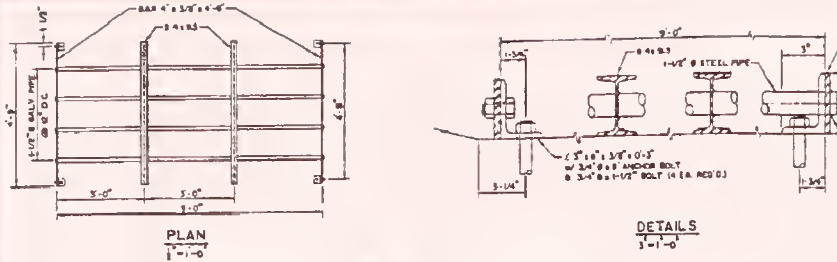
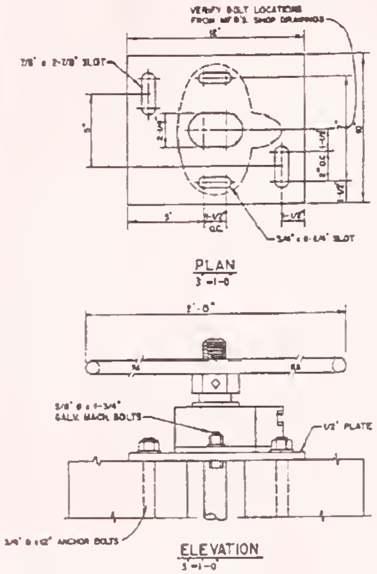
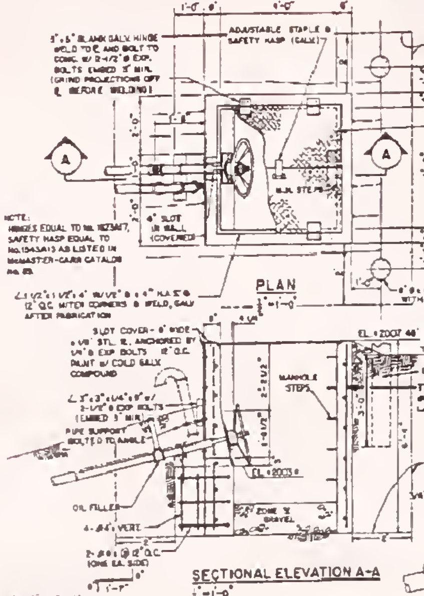


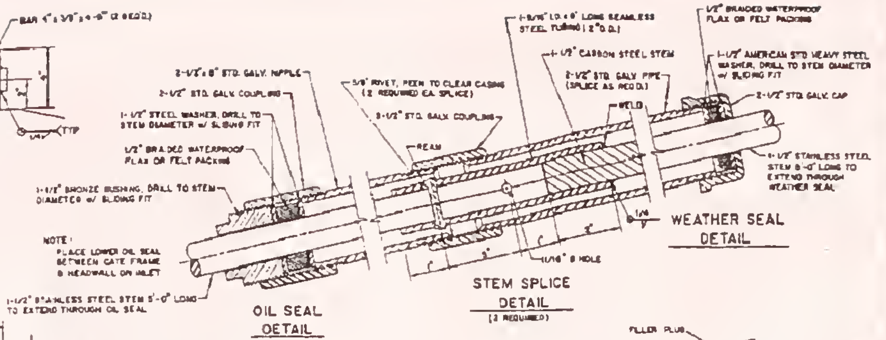
TRASH RACK

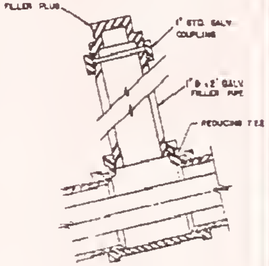


BASE PLATE


1'-0" 6"
4'-0"
6"
5" x 6" BLANK GALV. HINGE WELD TO ℄ AND BOLT TO CONC. w/ 2-1/2" Ø EXP. BOLTS EMBED 3" MIN. (GRIND PROJECTIONS OFF ℄ BEFORE WELDING)
ADJUSTABLE STAPLE & SAFETY HASP (GALV.)
STRUCTURAL EXCAVATION & BACKFILL PAY LIMITS (TYP.)
1/4" CHECKER ℄ PAINT WITH COLD GALVANIZING COMPOUND
A
A
M.H. STEPS
4" SLOT IN WALL (COVERED)
2'-0"
4'-0"
1'-0"
NOTE: HINGES EQUAL TO No. 1673A17, SAFETY HASP EQUAL TO No. 1543A13 AS LISTED IN McMASTER-CARR CATALOG No. 85
∠ 1 1/2" x 1 1/2" x 4" w/ 1/2" Ø x 4" H.A.S. @ 12" O.C. MITER CORNERS & WELD, GALV AFTER FABRICATION
PLAN
1/2" = 1'-0"
6" Ø x 6'-0" CMP FILLED WITH CONCRETE
SLOT COVER - 6" WIDE x 1/8" STL. ℄, ANCHORED BY 1/4" Ø EXP BOLTS 12" O.C. PAINT w/ COLD GALV. COMPOUND
∠ 3" x 3" x 1/4" x 6" w/ 2-1/2" Ø EXP BOLTS (EMBED 3" MIN.)
PIPE SUPPORT BOLTED TO ANGLE
EL. + 2007.46'
TOP OF DAM EL. + 2007.0
6" x 6'-0" CMP
TYP WALL REINF #4 x @ 12" O.C. EA. WAY CENTER IN WALL, LAP ALL HORZ STEEL AROUND CORNERS
MANHOLE STEPS
2'-8 1/2"
1'-8 1/2"
3'-0"
6'-4"
EL. + 2003.0
OIL FILLER
4 - #4's VERT.
ZONE "X" GRAVEL
2'
2 - #4's @ 12" O.C. (ONE EA. SIDE)
6"
1'-7"
(8 TOTAL)
SECTIONAL ELEVATION A-A
1/2" = 1'-0"

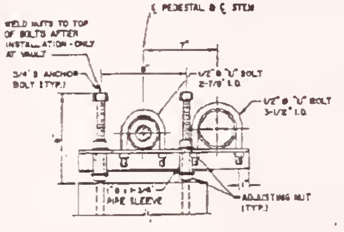
GATE LIFT PEDESTAL


1-1/2" BRONZE BUSHING, DRILL TO STEM DIAMETER w/ SLIDING FIT
1/2" BRAIDED WATERPROOF FLAX OR FELT PACKING
1-1/2" STEEL WASHER, DRILL TO STEM DIAMETER w/ SLIDING FIT
2-1/2" STD. GALV. COUPLING
2-1/2" x 6" STD. GALV. NIPPLE
NOTE: PLACE LOWER OIL SEAL BETWEEN GATE FRAME & HEADWALL ON INLET
1-1/2" STAINLESS STEEL STEM 5'-0" LONG TO EXTEND THROUGH OIL SEAL
OIL SEAL DETAIL
5/8" RIVET, PEEN TO CLEAR CASING (2 REQUIRED EA. SPLICE)
2-1/2" STD. GALV. COUPLING
REAM
1-9/16" I.D. x 8" LONG SEAMLESS STEEL TUBING (2" O.D.)
1-1/2" CARBON STEEL STEM
2-1/2" STD. GALV. PIPE (SPLICE AS REQ'D.)
WELD
11/16" Ø HOLE
STEM SPLICE DETAIL
(2 REQUIRED)
1/2" BRAIDED WATERPROOF FLAX OR FELT PACKING
1-1/2" AMERICAN STD HEAVY STEEL WASHER, DRILL TO STEM DIAMETER w/ SLIDING FIT
2-1/2" STD. GALV. CAP
1-1/2" STAINLESS STEEL STEM 8'-0" LONG TO EXTEND THROUGH WEATHER SEAL
WEATHER SEAL DETAIL

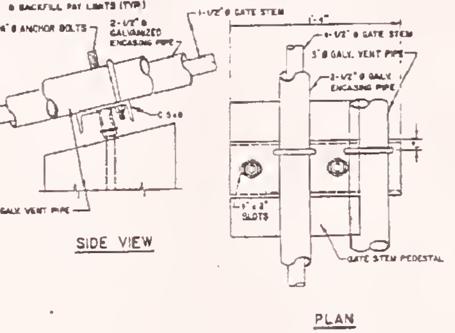


GATE STEM DETAILS

NTS

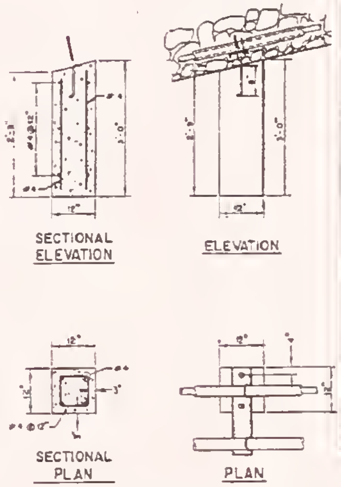

℄ PEDESTAL & ℄ STEM
WELD NUTS TO TOP OF BOLTS AFTER INSTALLATION - ONLY AT VAULT
3/4" Ø ANCHOR BOLT (TYP.)
7"
6"
1/2" Ø "U" BOLT 2-7/8" I.D.
1/2" Ø "U" BOLT 3-1/2" I.D.
1" Ø x 1-3/4" PIPE SLEEVE
ADJUSTING NUT (TYP.)

ELEVATION



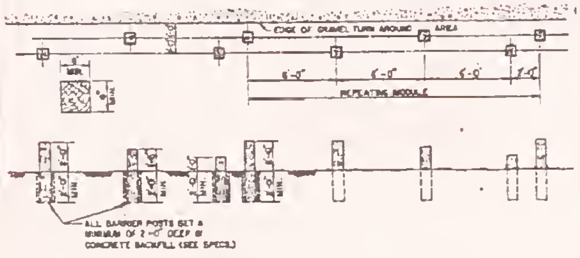
GATE STEM GUIDE

NTS



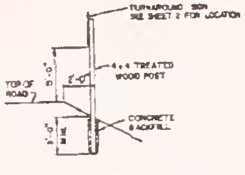
GATE STEM PEDESTAL

1/2" = 1'-0"


EDGE OF GRAVEL TURN AROUND AREA
8" MIN.
8" MIN.
6'-0"
6'-0"
6'-0"
2'-0"
REPEATING MODULE
2'-0" MIN.
ALL BARRIER POSTS SET A MINIMUM OF 2'-0" DEEP IN CONCRETE BACKFILL (SEE SPECS.)

BARRIER POST DETAIL

1/8" = 1'-0"



TURNAROUND SIGN POST DETAIL

NTS

Project No. ______ ID No. ______ Date ______ Designed ______ Drawn ______ Checked ______ Approved ______

No.	Revision	By	Date

GARTSIDE DAM
REHABILITATION PROJECT

GATE STEM AND PEDESTAL DETAILS

MONTANA PROFESSIONAL

HKM ASSOCIATES
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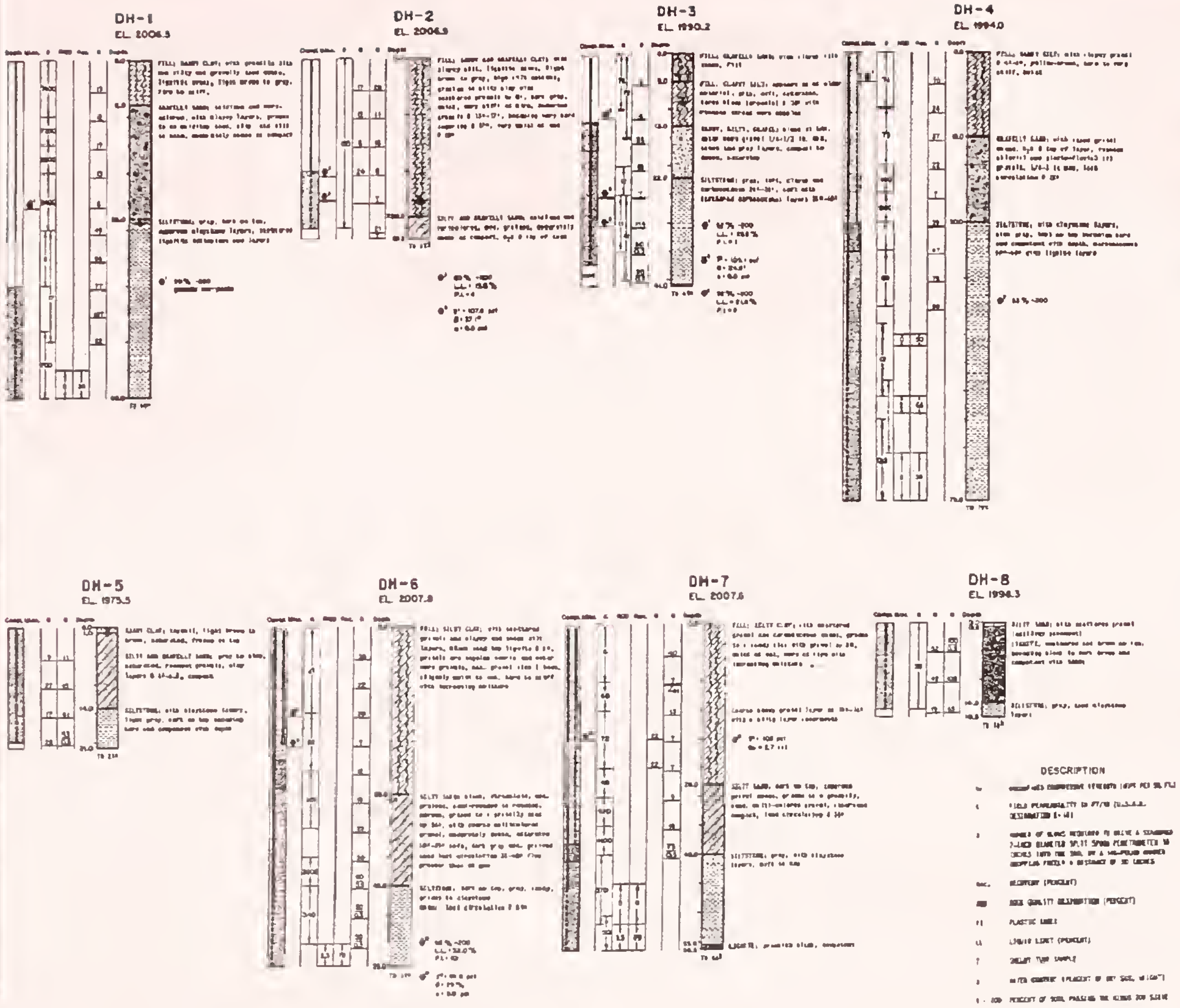
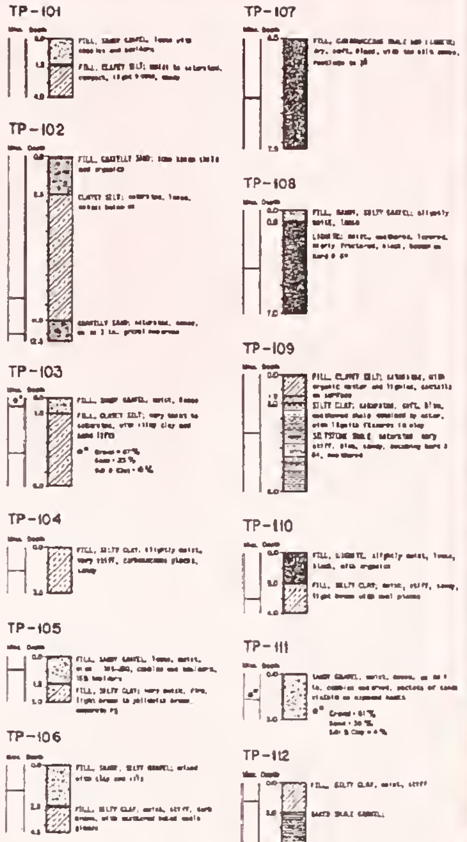
• Sheridan, Wyoming

Sheet No. 9
of 12

DRILL HOLE LOGS



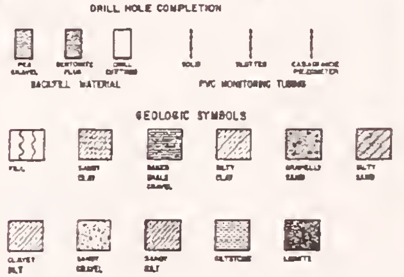
TEST PIT LOGS



DESCRIPTION

qu	UNCONFINED COMPRESSIVE STRENGTH (TONS PER SQ. FT.)
k	FIELD PERMEABILITY IN FT/YR (U.S.B.R. DESIGNATION E-18)
N	NUMBER OF BLOWS REQUIRED TO DRIVE A STANDARD 2-INCH DIAMETER SPLIT SPOON PENETROMETER 12 INCHES INTO THE SOIL BY A 140-POUND HAMMER DROPPING FREELY A DISTANCE OF 30 INCHES
Rec.	RECOVERY (PERCENT)
RQD	ROCK QUALITY DESIGNATION (PERCENT)
PL	PLASTIC LIMIT
LL	LIQUID LIMIT (PERCENT)
T	SHELBY TUBE SAMPLE
ω	WATER CONTENT (PERCENT OF DRY SOIL WEIGHT)
-200	PERCENT OF SOIL PASSING THE NO. 200 SIEVE
γd	DRY DENSITY (LBS. PER CU. FT.)
φ	INTERNAL ANGLE OF FRICTION (DEGREES)
c	COHESION VALUE (LBS. PER SQ. FT.)
▽	RECORDED WATER LEVEL ([illegible])
Compl.	DESCRIPTION OF DRILL HOLE COMPLETION

LEGEND



SCALE: 1" = 10' DRILL HOLES
1" = 4' TEST PITS

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Libby, Montana
Sheridan, Wyoming

Project No. [illegible] ID No. ____ Date [illegible] 1986 Designed ____ Drawn/LL Checked/PL Approved/LLD

No.	Revision	By	Date

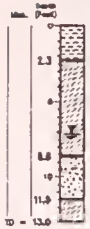
QARTSIDE DAM
REHABILITATION PROJECT

LOGS OF EXPLORATION HOLES

Sheet No. 10
of 12

TEST PIT No. 1
(TP– 1)

LOCATION : 19963.1 N, 18858.8 E
ELEVATION : 1983.9



TOPSOIL/GRAVEL: clayey, silty, loose to compact laminae structure to ≈ 1.8 feet. (Poorly Graded Gravel with Silty Clay and Sand, GP–GC)

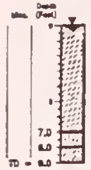
CLAY: soft, silty, lean, moist, brown to dark brown. (Silty Lean Clay, CL–ML)

GRAVEL: loose, silty, sandy, poorly graded, saturated (wet), multicolored in grey to brown matrix (Silty Lean Clay, CL–ML)

CLAY: silty, sandy, soft, saturated (wet), dark grey to brown, scattered interlayers fine to medium well graded sand, moist to wet, grey in clay, scattered deposits of weathered, soft, unconsolidated coal in sand and clay

TEST PIT No. 2
(TP– 2)

LOCATION : 20031.5 N, 19817.2 E
ELEVATION : 1978.8



CLAY: soft, silty, very high organic content, strong H_2S smell, appearance of accumulated organics, saturated, black, decomposing in Clay to Silty Clay. (Organic Clay, OH)

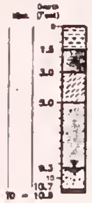
GRAVEL: poorly graded, silty, sandy with clay, black to dark grey, cobble size rocks, subrounded to rounded, difficult to pick depth exactly. (Poorly Graded Gravel with Clay and Sand, GP–GC)

CLAY: silty, sandy, slightly stiff to soft, saturated, dark grey. (Silty Clay with Sand, CL–ML), took sample from 8.0 feet to 9.0 feet, very elastic, rebounds when pressure is applied, has consistency and reaction of a gel

NOTE : Backwater from beaver dam standing adjacent to test pit site. Made observations based on returns showing in bucket and operator's feel (observations) of hole condition under water. Was able to measure depth at which clay was encountered (8.0').

TEST PIT No. 3
(TP– 3)

LOCATION : 19187.9 N, 19508.7 E
ELEVATION : 1978.7



TOPSOIL: Clay, silty, sandy, carbonaceous, dry, grey to black, scattered angular fragments of carbonaceous shale

CARBONACEOUS CLAY/COAL: very soft, loose, unconsolidated, carbonaceous clay (peat), dry, black. (Organic Clay, OH)

CLAY: silty, sandy, soft, moist, sandier with depth, dark brown to grey. (Sandy Silty Clay, CL–ML)

SAND: silty, some clay, well graded. (Well Graded Sand with Silty Clay, SW–SC)

GRAVEL: sandy, poorly graded cobble size, moist to saturated, water standing in hole at 10.4 feet, caving at 10.4 feet, more sand at 13.4 feet, strong mottlings from 10.4 feet to total depth. (Poorly Graded Gravel with Sand, GP)

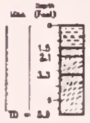
CLAY: soft, sandy, saturated, grey. (Lean Clay with Sand, CL)

NOTE:

1. EXPLORATION OF TEST PITS No. 1, No. 2, No. 3, & No. 4 (TP–1, TP–2, TP–3, TP–4) WAS PERFORMED ON JULY 5, 1989.
2. LOCATIONS OF TEST PITS No. 3 & No. 4 (TP–3, TP–4) ARE SHOWN ON SHEET 2.

TEST PIT No. 4
(TP– 4)

LOCATION : 19204.9 N, 18351.6 E
ELEVATION : 1982.7

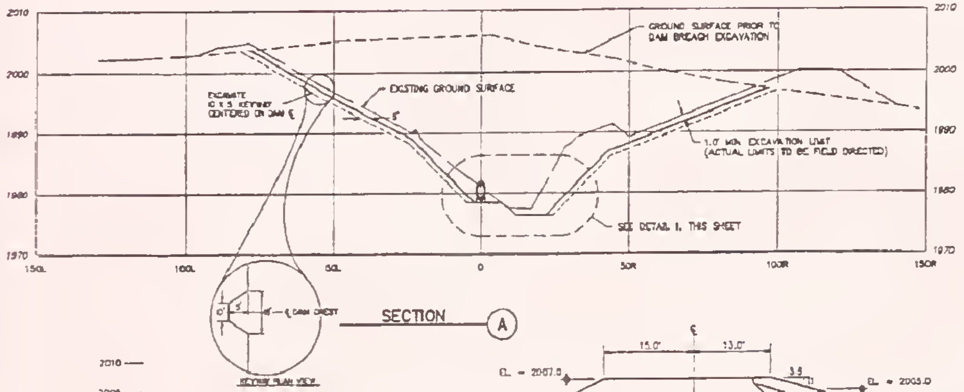


TOPSOIL: Clay, rooted, organic, grey to black

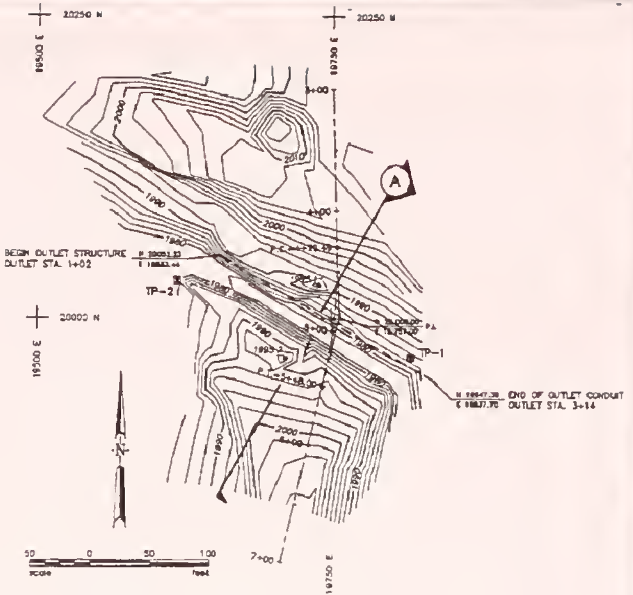
GRAVEL: poorly graded, soft to loose, rounded to subrounded, up to cobble size, dry to slightly moist. (Poorly Graded Gravel)

CLAY: silty, sandy, slightly moist. (Sandy Silty Clay, CL–ML)

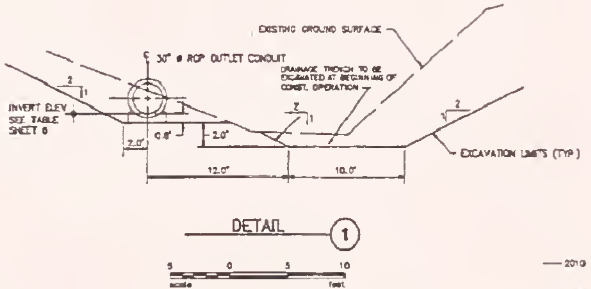
CLAY: silty, scattered clinker (burnt Shale), slightly moist, brown. (Gravelly Silty Clay, CL–ML)


2010
2000
1990
1980
1970
150L
100L
50L
0
50R
100R
150R
GROUND SURFACE PRIOR TO DAM BREACH EXCAVATION
EXISTING GROUND SURFACE
EXCAVATE 10 X 5 KEYWAY CENTERED ON DAM ℄
5'
1.0' MIN. EXCAVATION LIMIT (ACTUAL LIMITS TO BE FIELD DIRECTED)
SEE DETAIL 1, THIS SHEET
10'
5'
℄ DAM CREST
KEYWAY PLAN VIEW

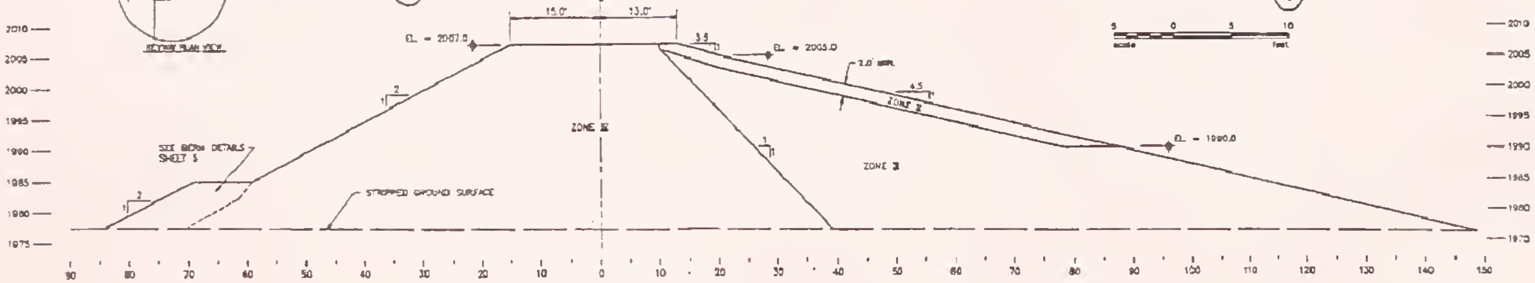
SECTION (A)



PLAN


EXISTING GROUND SURFACE
℄ 30" ⌀ RCP OUTLET CONDUIT
DRAINAGE TRENCH TO BE EXCAVATED AT BEGINNING OF CONST. OPERATION
INVERT ELEV. SEE TABLE SHEET 6
2
1
0.8'
2.0'
2.0'
12.0'
10.0'
EXCAVATION LIMITS (TYP.)
5
0
5
10
scale
feet

DETAIL (1)



MAXIMUM SECTION FOR BREACH BACKFILL

Project No. 89232.118 I.D. No. ___ Date Mar. 1990 Designed JT Drawn MA Checked ___ Approved ___

No	Revision	By	Date

GARTSIDE DAM
REHABILITATION PROJECT

BREACH DETAILS

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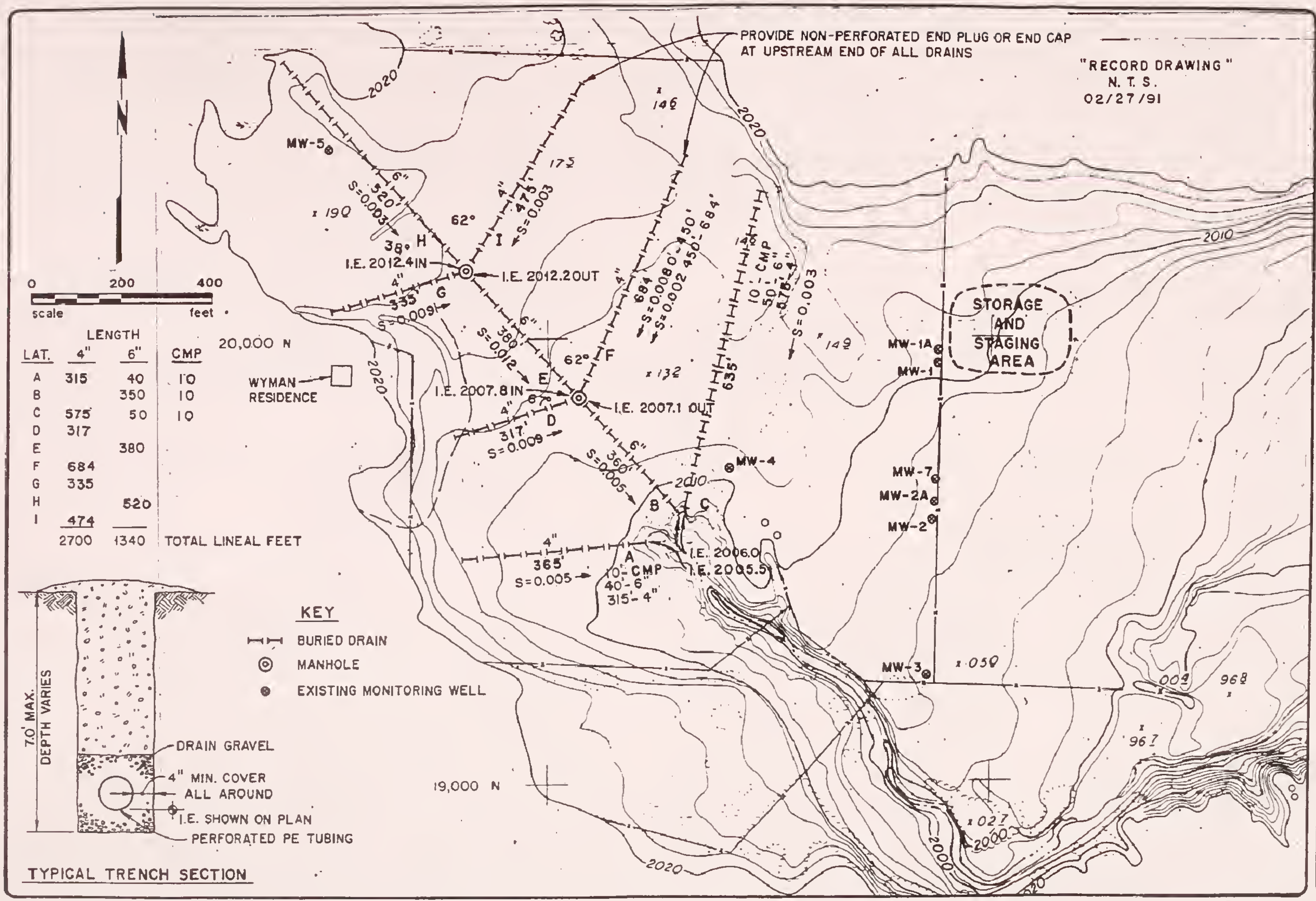
Sheet No.
11
of 12



PROVIDE NON-PERFORATED END PLUG OR END CAP
AT UPSTREAM END OF ALL DRAINS

"RECORD DRAWING"
N. T. S.
02/27/91

LAT.	LENGTH 4"	6"	CMP
A	315	40	10
B		350	10
C	575	50	10
D	317		
E		380	
F	684		
G	335		
H		520	
I	474		
	2700	1340	TOTAL LINEAL FEET

KEY

- ⊢⊣ BURIED DRAIN
- ◎ MANHOLE
- ⊗ EXISTING MONITORING WELL

TYPICAL TRENCH SECTION

GARTSIDE DAM - WYMAN DRAINS

PLAN and TRENCH DETAIL

HKM ASSOCIATES
ENGINEERS · PLANNERS
9M087.138
AUG. 1989

D29 2007